CORRUPTION AND HUMAN CAPITAL CONVERGENCE IN AFRICA

by Sam Blessing Victor

(300148394)

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Supervisor: Professor Kathleen M. Day

ECO 6999

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ABSTRACT

This paper studies the influence of corruption on human capital convergence in 46 African countries. Corruption is a phenomenon intricately woven in the fabric of many African countries' important sectors. With a panel data analysis, this study seeks to find out how the corruption index of countries impacts conditional convergence of human capital. I cluster the countries based on their levels of corruption and perform a pooled OLS estimation to investigate the question at hand. The results show the presence of conditional convergence in human capital for the sample and indicate that income inequality and population growth rate both affect human capital convergence significantly.

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1. Introduction

Africa is the second fastest growing region in the world and yet it has the most people below the poverty line in comparison to other continents (African Development Bank, 2017). There are fifty-five countries in the continent and it is filled with enormous natural resources, ranging from high deposits of crude oil in Nigeria to large volumes of cobalt in Congo amongst many others. Yet, Africa ranks high on measures of corruption, it is plagued by low education quality, and it is not a strong global competitor. With African being "the world's most youthful continent" (IBRD, 2020), it is expected that this favourable age profile would be associated with high levels of productivity, an active labour force, and developing economies with a high growth rate. This is not the case, as the education statistics for the continent do not have a good outlook. As of 2014, Sub-Saharan Africa had the highest rate of exclusion of children from school, recording 21% of primary school age children denied access to education (UNESCO Institute for Statistics, 2016). The publication also observed that girls had higher chances of being excluded from education than boys. Approximately nine million girls in Sub-Saharan Africa will never attend school, compared to six million boys (UNESCO Institute for Statistics, 2016). Also, the poverty rate in the largest populated African country, Nigeria, was recorded to be a whopping 40% (National Bureau of Statistics, 2020). This means that approximately eighty-three million live on less than $381.75 per year. We also observe poverty rates of 32.5% and 73% for Egypt and South Africa respectively (United Nations Development Programme Statistics, 2018).

Many stylised facts such as these show that human capital in Africa is lacking, a lack that emanates from the high levels of poverty recorded in the majority of the countries. Childhoods that are disadvantaged with little to no education culminate in a human development trap, as explained by

the 2019 World Bank Group publication, *Accelerating poverty reduction in Africa*. The human development trap will confine families and in the long run, generations, in cycles of poverty (Beegle and Christiaensen, 2019). Thus, human capital investment is necessary to correct this deep-rooted problem.

Corruption, on the other hand, is a persistent problem associated with many countries globally, more so in African countries. According to Momoh (2015), corruption exists in economic, political and institutional forms. Corrupt practices are found in the hierarchal levels of governance, and this is a dominant factor that has stunted development in Africa (Momoh, 2015). According to Transparency International (2019), more than one in four people have to pay a bribe before accessing certain public services, like health care and education. The survey also observed that the majority of respondent citizens had the opinion that corruption is on the increase (Transparency Internationa, 2019). These corrupt practices include bribery, embezzlement, money laundering and many other economy-destabilising activities. The poorest and most vulnerable of the population are susceptible to the negative effects of these practices, as it is observed that while 36% of the poorest population paid bribes for public services, only 19% of the wealthiest population paid bribes in the survey period. With continued corruption practices in governance and public offices, it is a given that corruption will have an impact on the human capital of these countries. Diversion of required funding for schools, having too little money to pay bribes that grant access to education, inadequate expenditure on the education sector by the government due to misallocations are some of the ways through which corruption might affect human capital. Thus, from a human development perspective, attention must be paid not only to the rate of income growth in these countries, but the contribution of said growth to the enhancement of the population's standard of living.

Many economists have dedicated extensive research to the study of economic growth and convergence. The main theory of reference is the Solow-Swan Neoclassical growth model presented by Solow (1956), which posits that in the long run, economies will converge to their steady state equilibrium. The theory ascribes this convergence of countries' economic growth to factors such as physical capital, the savings rate, technological progress and the population growth rate. The concept of convergence is frequently used in studies of economic growth [Khan (2013), Barro (2016), Wigger (1996)] and in economic development [Erdal et al. (2006), Ortega et al. (2016)]. However, the application of convergence to human capital is a relatively new and slightly overlooked area of research, with one of the first analyses being by Coulombe and Tremblay (2001).

Human capital is assumed to converge for different countries just as physical capital does in the Solow growth model. Human capital is subject to diminishing returns and as such, it can converge to a given steady state. A situation where the human capital of the whole of Africa converges to a single equal steady state is called absolute convergence and a situation where the human capital of different countries in Africa converges to different steady states based on certain factors such as differences in institutions or investment levels in education is called conditional convergence. A human capital steady state is a state where the human capital stock observes zero growth. This study will observe the conditional convergence of human capital in African countries to the steady state and how corruption affects this process.

Walker (1986) ascertains that "capital investment in human capital is the alternative way forward for Africa" (p. 10). This means that increased investment in human capital might cause these countries ridden by a human development trap of some kind, to catch up to countries with high

levels of human capital and development. How do these countries then catch up to high levels of human capital if corruption exists predominantly in all sectors? This is the question this study asks. I seek to analyse and find out the effect of corruption on human capital stock convergence in Africa.

Scope of the Paper

There are a few studies that analyse human capital convergence in Africa, such as Bourdane and Fahim (2019), Nor-eddine et al. (2018) and some others. Most of the studies of convergence in Africa focus on growth and development convergence such as Sy (2014), Khan (2013) and some others. There is therefore a gap to be filled in this area. My study seeks to add to the body of research work on the said topic.

I will examine convergence in human capital in 46 African countries. The sample will be disaggregated into 3 overlapping sub-period panels with two year gaps. The macro data set is retrieved from the World Bank Development Indicators for the period 2012 to 2018. The dependent variable is a measure of human capital.

The rest of the paper is organized as follows: section 2 presents the literature that relates to corruption and economic growth, human capital and economic growth, corruption and human capital and the gap in related literature**.** Section 3 describes in detail the data to be used. Section 4 covers the model and research methodology. Section 5 has the estimation results and in section 6, I present my main findings and the conclusion.

2. Literature Review

This section will expose a review of related literature on the subject matter.

I start with evidence on corruption and economic growth, then I discuss the findings on human capital and economic growth before considering human capital convergence and the gap in related literature. Human capital is a key indicator of a nation's capacity and development rankings and this study seeks to find out how corruption affects human capital in Africa.

Corruption has multidimensional and extensive effects on the overall state of any country; its effects may affect the social and economic activities of any nation. Due to its vastness and ambiguity, it can be difficult to define it as a concept. Corruption has been defined as "the use of public office for private gain" (Gray and Kaufmann, 1998). Also, Shleifer and Vishny (1993) define corruption as the "sale by government officials of government property for personal gain". However, in recent times, these definitions have proven to be inadequate. It has been speculated that corruption is not only the abuse of public office, as any business can engage in corrupt practices. The International Transparency Agency defines corruption as "the abuse of entrusted power for personal gain" (Transparency International, 2020) and it afflicts both the public and private sectors. This definition illustrates that there is a public service to be provided by an entrusted power and the public that needs to benefit from such service. Thus, corruption includes, but is not limited to acts of bribery, embezzlement, dishonesty, misconduct, red-taping and favoritism.

Several authors have carried out research on the reasons for corruption, its social consequences and corruption's impact on macroeconomic variables (including economic growth and investment). To properly study the effect of corruption on macroeconomic variables, one must first

ensure the reliability of its measurement. Corruption in itself is difficult to measure, so the measurements of corruption are mostly through how it is perceived in a given country or environment. Some of the major corruption measurement indexes based on perception levels are the Bribe Payers Index (BPI), the Global Corruption Barometer (GCB), the Corruption Perceptions Index (CPI), the Control of Corruption Index, Business International and Freedom from Corruption (Malito, 2014). Several studies have examined the negative impacts of corruption on economies; these impacts include but are not limited to reduced economic growth and development, decrease in investments, inefficiency of public expenditure and deterrence of business development. Other studies such as Leff (1964) and Lui (1985) found that corruption may lead to saved time and efficiency. They posit that in systems where bribery is the norm, paying money to bureaucrats helps to hasten processes without creating any cost to the society.

2.1 Corruption and Economic growth

Numerous studies have been carried out on the effects of corruption on economic growth. These studies include Mauro (1995), where he identifies the channels through which corruption and other institutional factors may affect economic growth. He also quantifies the magnitude of these effects. The study finds that a significant portion of the effect of corruption on growth works through its effect on the total amount of investment. In a further study, Mauro (1996) examines the unexplored relationship between corruption and government expenditure composition. The results of this study reveal that the composition of government expenditure is altered by corruption, specifically by the significant reduction of government spending on education.

Tanzi and Davoodi (1997) also provide evidence that high levels of corruption are associated with higher public investment, lower government revenues, lower expenditures on operations and lower

quality of public infrastructure. Through these channels, corruption lowers growth. They note that high public investments in countries that have high corruption levels should not necessarily be praised, as these high investments may be channels for carrying out various forms of corruption.

Mo (2001) analyses the channels through which corruption might affect economic growth. Using a data set similar to the one used in Mauro (1995), the author builds an analytical framework to find these channels and the impact corruption has on GDP growth rate. He finds the channels to be political instability, human capital and investment. Also, he notes that the highest effect on the economic growth rate was through political instability, which accounted for approximately 53% of the total effect.

Kutan et al. (2009) conducts a study that provides empirical evidence of the impact of corruption on economic development in Middle Eastern North African (MENA) and Latin American countries. The study finds that corruption has no significant relationship with economic growth in Latin American countries, even though it significantly improved economic development in MENA countries in the given period. However, Guetat (2006) and Gyimah-Brempong and Camacho (2002) obtain quite different results. They find that corruption deters economic growth in MENA and Latin America countries. This difference in results may be a result of the different sample periods in the studies, or the fact that Kutan et al. are interested in the impact of corruption on the level of income per capita, while the latter group focuses on the growth of income per capita.

Aliyu and Elijah (2008) evaluate the effects of corruption on economic growth in Nigeria. They study the direct and indirect effects through channels such as physical capital, labour and human capital. The results observed show that corruption has negative effects on total employment and human capital development and interestingly, it has a positive impact on government capital

expenditure. The authors were able to detect the direct and indirect impacts of corruption on economic growth in Nigeria.

Aidt (2009) evaluates the relationship between corruption and economic development. The author questions if corruption is a hindrance or aids progress in economic development. Whilst the macro level results show little evidence of the relationship between the two variables, further testing shows that corruption hinders sustainable development.

Some other studies including Svensson (2005), Bliss and Tella (1997), Dissou and Yakaustava (2012) and Choi and Thum (1998) have carried out comprehensive research on the causes and effects of corruption. However, most of these studies have only focused on the relationship between corruption and economic growth, investments, inflation or public expenditure. This creates a gap which this paper seeks to fill.

2.2 Human capital and Economic growth

Studies on human capital and growth relationship include Obialor (2017), who carries out a study to examine the impact of human capital investment on economic growth in Ghana, Nigeria and South Africa. Using a Vector Error Correction Model, co-integration methods and unit root testing, the results are mixed for the three countries and the author concludes that the effects of human capital investment on economic growth are country-specific.

To examine the growth effect of health in Ghana for the periods 1982-2012, Boachie (2015) employs an ARDL bounds test approach to co-integration and finds that economic growth is significantly enhanced by health in the short and long run, noting that the short run effect was lower than the long run effect. Amaghionyeodiwe (2018) conducts a study on fifteen West African countries to investigate the impact of government spending on education on economic growth. The

panel study finds that there is a positive correlation between the mentioned variables and long-term Granger causality. This means that higher investment in education can culminate in increased economic growth in the short and long run.

Ehimare et al. (2014) evaluate the relationship between government expenditure and human capital in Nigeria. Using a normalized co-integration method, the study finds that over the years, the efficiency of government expenditure on education performance has reduced significantly.

2.3 Corruption and Human capital

Studies on corruption and Human capital include Ortega et al. (2016), who conduct a study on corruption and convergence in human development using data from sixty-nine countries. They maintain that human development in developing countries has to "catch up" to the levels as seen in developed countries. The authors break down the Human Development Index into its three components: life expectancy at birth, average years of schooling and Gross National Income per capita. Observing if these three components converge to the steady state level across countries based on corruption influences, they use the Corruption Perception Index (CPI) as a measure of corruption, the clustering method to group with higher and lower levels of corruption and carry out an Ordinary Least Squares estimation. The results show that corruption is a significant roadblock to human development because it diverts financial resources from social welfare services and reduces economic growth. Furthermore, the countries with the highest levels of corruption had the slowest speed of convergence in human development and vice versa.

Boikos (2016) investigates the impact of corruption on human capital accumulation. He posits that corruption affects human capital in a non-linear relationship, through two channels. The two channels are its effect on public expenditure in education and investment on physical capital. Using

Ordinary Least Squares and Two Stage Least Squares methods, he adapts the variable of voice and accountability index as an instrumental variable for corruption. The results show that the effect of corruption on human capital through its effect on physical capital investment is larger than the effect in public expenditure in education. That is, corruption has a negative effect on physical capital and a declining effect on public expenditure on education.

Hoa (2019) conducts a panel study of the impact of corruption on human capital accumulation in the sixty-three Vietnamese provinces. He studies human capital in two steps, implying a non-linear relationship. The two steps are the effect on the educational process and the effect on educational outcomes and how it translates into productive labour in the labour market. The results show that corruption has a negative effect on high school enrolment rates due to the fact that it reduces the impact of public education funding. Also, corruption increases the chance that local education systems will get financing from the federal government.

Dridi (2014) assesses the relationship between corruption and education in a cross-country regression analysis. He uses multiple indicators of education; the secondary school enrolment rate and secondary school repetition rate amongst others. Utilizing the Two Stage Least Squares method and using the latitude of each country and the share of Muslims in the population as instruments, he finds that the countries with higher levels of corruption record higher secondary repetition rates. The results also show that a one-point increase in corruption decreases secondary school enrolment rate by approximately ten points.

Most of the literature reviewed has found the expected negative impact of corruption on economic growth and human capital, albeit in different countries and sample sizes. They also observe the

importance of human capital to growth in an economy. These studies set the tone for what the expected results from this research could be.

Against this backdrop, I observe a few gaps in the reviewed literature. Aside from adding to an area that is not very researched area in Africa, studies on human capital convergence using a wide range of countries in their samples have failed to correct for heteroscedasticity while carrying out their test for convergence, for example, Boikos (2016) observes heteroskedasticity at a significance level of 10%. This study eliminates the possibility of heteroscedasticity by using robust standard errors. Besides, Transparency International, in 2012, found a way to measure corruption more efficiently and accurately. This new measure cannot be compared with the previous years' index, as pointed out by the organisation (Transparency International, 2012). This separates my study from the previous literature on the said subject, some of which dates back to 2001 (Mo, 2001). With the use of the newly recalculated index, my results are predicted to be more representative of the current state of things than pre-2012 results would be. The study is more relevant because it covers recent years and gives a more accurate information on the subject. Finally, human capital convergence in Africa is a sparsely researched area and this research contributes to the existing literature.

3. Data description

In this section, I discuss the type of dataset I will use, which is a secondary macro-level data set sourced from World Bank Development Index (WDI), Transparency International and other statistical sources. The study will examine a sample of 46 African countries from 2012-2018. Islam (1995) rightly observed that yearly time spans are too short to observe convergence. As such, the panel analysis will disaggregate the 7-year span [2012-2018] into three overlapping sub-groups.

The sub groups will be set to three years each, with a two-year gap as follows: 2012-2014, 2014-2016 and 2016-2018. This means that the panel data will use cross sectional observations of the African countries and time series observations during the period frame.

Dependent variable

The dependent variable is a measure of human capital. Due to the unavailability of data on the Human Capital Index (HCI) for several countries in Africa, this study will use the Human Development Index (HDI) sourced from the United Nations Development Programme Human development report databank. The HDI includes life expectancy at birth, an education index and the standard of living in its composition. The HDI differs from the HCI in a few ways; for example, it includes per capita income, while the HCI does not. HCI also measures the amount of human capital that a child can expect to acquire by age 18, given the health and education conditions in her country of residence. (World Bank Group, 2020). Both indices include education and health components; thus, using the HDI as an alternative indicator in the absence of data for the HCI can be justified. The HDI ranks from 0 to 1, 0 meaning very low human development and 1 meaning very high human development.

Independent variables/Covariates

Corruption is the key independent variable. The corruption measure is sourced from the Transparency International data bank and it is called the Corruption Perception Index (CPI). While corruption is difficult to measure accurately due to its multifaceted and intangible nature, the index is measured based on corruption perception in a given country. It ranks corruption from 0-100, 0 meaning highly corrupt and 100 meaning very clean. The index is measured based on subjective data and uses up to 15 different sources in order to reduce measurement errors. I chose to use the

CPI not only because of its popularity amongst researchers, but also because its scope and accuracy have improved over the years (Hamilton and Hammer, 2018).

The corruption data are collected for the years 2012 to 2018. Due to the change in the measurement of the Corruption Perception Index (CPI) in 2012 by the Transparency International, CPI data before 2012 cannot be compared to CPI data from 2012. In the former measurement method, CPI was calculated over a total score of 10, while the new measurement method brings into account some changes in the calculation process and ranks corruption out of a possible score of 100. Transparency International gathers the data through independent surveys and expert assessments and concentrates on public sector corruption. The a priori expectation is that there is a negative relationship between corruption and human capital. This means that as corruption increases, human capital should experience a deterioration, other things being equal. Thus, countries with higher corruption levels might record a slower pace of achieving desired human capital levels. A reduction in the corruption perception index (CPI) means that a country is becoming more corrupt and vice versa. I divide the countries into two groups by their corruption perception indices. The two groups are high corruption countries and low corruption countries, where high corruption countries are countries with a value below the average lnCPI figure of 3.3075, and low corruption countries are countries that have a corruption value above the average figure. I then create a dummy variable for these two groups. High corruption is represented by 1 and low corruption is represented by 0. This single dummy measure will be incorporated into my analysis and represent corruption in the model.

The Population growth rate is the rate at which the number of people in a populace increase at a given time. This data is collected yearly for 46 African countries and is sourced from the World

Development Indicators (World Bank). Pulok (2010) uses this variable in his human capital convergence model and this inspires the addition of the variable to my model. This variable is relevant because human capital can be affected by the population size of a country. The growth rate of population is expected to be proportional to the growth rate of human capital development. However, in countries where the population growth rate is high, this may not be the case, as the government might not be able to match human capital investments with population growth over time. This will in turn lead to reduced human capital per capita (National Research Council, 1986). This is more likely to be the case in African countries, where the population grows faster than the human capital investment rate.

Gross Savings (% of GDP) is the total domestic savings of each country. It includes public, household and private sector savings. The savings rate of a country is mostly used in economic growth convergence studies. It is likewise important in this study as it is an exogenous variable that can likely affect the human capital convergence of these countries. I have included the savings rate in the model because it can affect the level of human capital investments and thus its convergence. It is expected that countries with higher domestic savings will increase their human capital investments. So, the higher the domestic savings rate, the higher the human capital convergence growth. This data is sourced from the World Development Indicators (World Bank).

Income inequality is measured by the Gini coefficient, which is a measure of the uneven distribution of income in a population. This data is sourced from the World Inequality Database (n.d.). The Gini coefficient is the appropriate index for measuring income inequality because it is Lorenz-consistent. It is also a widely used in empirical analysis. I have included income inequality in the model because it can affect human capital convergence, in the sense that a highly unequal

country with the rich getting richer and the poor, poorer, might record a slower pace of achieving desired human capital development levels. An increase in the Gini coefficient indicates that the population being observed is becoming more unequal in terms of income.

The independent variables are averaged over time, to correct for missing completely at random (MCAR) data. Averaging the explanatory variables ensure that when a country has only one recorded observation in two years, the observation is still included in the analysis. However, if the data is not missing completely at random and many observations are missing, then averaging the explanatory variables will not be sufficient and the resulting measurement error may cause the results to be biased. The lack of some data observations is due to inadequate data gathering in some of the sample countries rather than a systematic reason.

Table 1 presents some descriptive statistics such as the minimum, maximum, mean and standard deviation for the variables under purview. On average, the standard deviation values are low, implying that the data of the sample set are close to the average and do not vary much. The highest standard deviation is for the corruption index (1.058). This indicates quite a large disparity in corruption for the different countries in the sample.

Table 2 shows the within and between standard deviations of the variables in the sample period. The between effect shows the variation across cross-sectional units, which is in this case: countries, while the within effect shows the variation over time of the observed variables. In Table 2, I observe the between effect is higher than the within effect for all the variables. LnHDI, for example, has a between standard deviation of 0.2496 while its within standard deviation is 0.0263. This connotes that the variable varies more between countries than it does over time. This also

applies to lnCPI, the corruption perception index, which records between and within effects of 1.0517 and 0.1098, respectively.

4. Model and Methodology

For this analysis, I adapt the model used by Ortega et al. (2015). I choose this linear model because it fits the results I seek to acquire in this study. I also adopt elements of the definition of the dependent variable using the study of Coulombe and Tremblay (2001) as a model. The model is written as follows:

$$\frac{1}{p}\left[ln\, h_{i,t} - \ln h_{i,t-p}\right] = \alpha + \beta \ln h_{i,t-p} \;\; + \varepsilon_{i,t} \qquad (1)$$

for t = 1,…,T and i = 1,….,N, where the variables are defined as follows:

$h_{i,t-p}$: HDI for a country *i* in period *t-p*

$h_{i,t}$*:* HDI for country *i* in period *t*

p: gap between periods

β: predicted speed of human capital convergence term

α: constant term

ε: the error term

The subscript *i* represents the specific country and the subscript *t* represents the time period, which in this case is years that the sample covers. *p* is set to 2 indicating the two-year gap in each sub-period. The natural log of the variables is taken to normalize them.

I include additional variables, the dummy variable and an interaction term in the model to determine the influence of corruption on conditional convergence in human capital. This modifies the model to be

$$\frac{1}{2}\left[\ln h_{i,t} - \ln h_{i,t-p}\right] = \alpha + \beta_1 \ln h_{i,t-p} + \beta_2 \ln POP_{i,t} + \beta_3 \ln INEQ_{i,t} + \beta_4 \ln SAV_{i,t} + \gamma_{HC} HC_i + \beta_{HC}(\ln h_{i,t-p} * HC_i) + \varepsilon_i \quad , \qquad (2)$$

where the newly included variables are:

POP: the population growth rate (yearly)

INEQ: Income inequality measured by the Gini coefficient

SAV: Gross savings as a percentage of GDP

HC: Dummy for degree of corruption, where *HC*=1 if a country is highly corrupt and is 0 if otherwise

$\ln h_{i,t-p} * HC_i$ is an interaction between the lagged human capital measure and the corruption dummy.

Other terms have been previously defined. The *p* has been replaced been replaced by 2, the year gap in each sub-period.

I will use the pooled OLS regression technique to estimate equation (2). I will also estimate some versions of the model with cluster-robust standard errors to compare possible differences in the standard errors. This accounts for heteroskedasticity that may be observed across the countries. It will be used to correct the standard errors that are not independently and identically distributed (Williams, 2020).

5. Estimation Results

In this section, I discuss the estimation results. First, I explain the pooled OLS estimates, then I carry out a diagnostic test for Multicollinearity and to conclude this section, I perform further estimations.

5.1 Pooled OLS results

The regression estimation results are observed in Table 3. The column 1 shows the pooled OLS results without robust standard errors. Here, I observe that the coefficient of lagged HDI (HDIlag) is -0.0141 and it is statistically significant at 5% level of significance. This connotes that, all other things being equal, conditional human capital convergence is occurring in the sub-periods, as β is < 0. Countries in the sample are conditionally converging in human capital to their various steady states. The second column incorporates the robust standard errors treatment and an increase in the standard error is observed for lagged HDI, although its coefficient is still statistically significant at the 5% level. The panel-robust standard error removes hints of heteroskedasticity or autocorrelation that may have been present in the idiosyncratic errors in column one. HC is the dummy variable for the degree of corruption, where the dummy equals 1 if the country is highly corrupt and 0 if otherwise. The reference group in this case are the low corruption countries. The coefficient estimate of high corruption countries is 0.00406, but statistically insignificant, which suggests that corruption does not in fact influence the growth of human capital.

The coefficient of income inequality (INEQbar) is at -0.0271, which is statistically significant at the 5% level of significance. This means that higher inequality in a population is associated with a slower rate of conditional convergence in human capital, all other things being equal. That is, a

1% increase in the Gini coefficient inequality is associated with a 2.7% decrease in the rate of growth of human capital.

The third column includes an interaction term in the regression. An interaction term is used to observe the different degrees of corruption and how they may differently affect human capital convergence. In column 3, I observe that the lagged HDI (HDIlag) coefficient estimate becomes less negative (-0.0186) when its interaction with the high corruption dummy is included in the regression. It still connotes that high corruption degree is associated with slower growth. This also proves that there are interaction effects present. The estimate of the interaction term is -0.00883; this would mean that highly corrupt countries have a slower growth rate of HDI by 0.0883 percentage points than countries with relatively low corruption levels, however this coefficient estimate is statistically insignificant.

5.2 Multicollinearity Test

Upon conducting an overall test of significance (F test), I observe an F value of 3.396 and a p-value of 0.0109, which is statistically significant at the 1% level of significance. Therefore, I can reject the null hypothesis that the regression estimates are jointly zero and retain this regression because the model has considerable explanatory power. The F-statistic value suggests that the model has explanatory power, but most of the coefficient estimates are statistically insignificant. This motivates the need for a diagnostic test of multicollinearity.

To ensure that the insignificant coefficient estimates being observed are not due to multicollinearity, I carry out a diagnostic test in Table 4. The Variance Inflation Factor (VIF) method is a investigative check for examining the presence of multicollinearity in an estimation. The rule of thumb is that a VIF greater than 10 is problematic and may indicate high

multicollinearity levels between the explanatory terms. The Table 4 shows the mean VIF to be 1.112 and the highest VIF observed to be 1.176. These indicate that there is no correlation between the variables used in this regression. Thus, with the 1.157 VIF value observed for corruption, we can conclude that corruption is not correlated with domestic savings rate, population growth rate or income inequality in the estimation.

5.3 Further estimations

To try to improve the strength of the results, I run several additional estimations to further analyse the data.

In Table 5, the first two columns show the result of the pooled OLS output of the regression with the original corruption variable instead of the dummy variable *HC*. This estimation excludes the corruption dummy and examines the corruption in various countries together, without clustering them into level of corruption groups. Column (1) shows the plain pooled OLS regression and the second column shows the regression with panel-robust standard errors. The coefficient estimate of lagged HDI (HDIlag) is again negative as in the original estimation. It is also statistically significant at the 1% level of significance in both columns. This connotes that human capital convergence is occurring in the time frame. Estimating this model improves the statistical significance of lagged HDI from the 95% level of confidence to the 99% level of confidence. The corruption coefficient estimate remains statistically insignificant and is observed to be 0.00109. The population growth coefficient estimate, on the other hand, improves. The estimate is 0.00206 and is statistically significant at the 10% level of significance when the standard errors are robust, with a p-value of 0.075. Therefore, other things being equal, a one percent increase in population growth rate is associated with a 0.206% increase rate of growth of human capital in Africa. Income

inequality also shows an improvement in this estimation. Income inequality has a coefficient estimate of -0.0322 and it is statistically significant at the 10% level of significance with a p-value of 0.09. This connotes that a 1% increase in the Gini coefficient is associated with a 3.22% slowdown in the growth rate of human capital, all other things being equal. The coefficient estimate of income inequality here is more negative than was observed in the Table 3 (-0.0293). This indicates that income inequality negatively impacts human capital convergence a little more than what was observed previously.

To ensure that the results in this study are not biased due to the way in which the corruption dummy variable was constructed, I create another dummy called "Very high corruption". It includes only the top 25% most corrupt countries. If a country is very corrupt (highest 25^{th} percentile), then the dummy is equal to 1 and equal to 0 if otherwise. The results of the estimation are observed in the column 3 of Table 5. The coefficient estimate of the very high corruption dummy is negative and statistically insignificant at the 10%, 5% and 1% levels of significance. Doing this estimation serves as a sensitivity analysis for the corruption clusters. Thus, the insignificance of the coefficient of the corruption dummy in Table 4 does not seem to be due to the definition of the variable HC.

Table 6 uses the Education Index (EDUC) in place of the Human Development Index (HDI). The index is created by the United Nations Development Report and is a component of the HDI. The index consists of adult literacy rate and combined gross enrollment ratio for all levels of education. I seek to find out if the education component of the HDI is experiencing conditional convergence and if this can be attributed to corruption and other explanatory terms. I treat the education index the same way I treated the HDI in equation (2) and use the same overlapping sub-periods. I run

the estimation using the pooled OLS technique and further estimate cluster-robust standard errors in the second column. The results show that the coefficient of the lagged value of education index is negative and statistically significant at the 1% level of significance. This connotes that within the time frame, there is evidence of conditional convergence in education. The other variables in the estimation are however observed to have statistically insignificant coefficients.

Table 7 includes estimations that have been carried out by collapsing the panel dataset into a cross section of the 46 countries for 2012-2018 period. I attempt this estimation because, as observed in Table 2, the variables in the model vary more across countries than across time. This is done by using a lag of six time periods. The independent variables are averaged across time and each country has a single value for each variable in the newly formed cross-sectional data. The first column includes the original corruption variable, while the second column is treated with robust standard errors. Finally, the column 3 includes the corruption dummy instead. The results show that human capital convergence is present with a coefficient estimate of -0.0881 in the first estimation with robust standard errors. Using the corruption dummy reduces the coefficient estimate even more so, to -0.0905. The coefficient estimate is significant at the 10% level of significance.

6. Conclusion

The results of the estimation show evidence of conditional convergence in human capital in the sample group – African countries. Conditional human capital convergence means that countries are converging to different steady states. The key independent variable results were, however, statistically insignificant. While I observe positive coefficient estimates for domestic savings and negative coefficient estimates for the corruption interaction term, in line with theory and reviewed

literature, the results are statistically insignificant and as such, inconclusive. Further estimations to improve the strength of the study proved to be useful, as I find that income inequality and population growth both have effects on the speed of human capital convergence in Africa. Further evidence shows the presence of educational convergence in Africa over the observed time period. This in itself is good; however, observing if corruption slows down this convergence speed in a statistically significant estimate, would have been a lot better.

The panel data was treated with cluster-robust standard errors to correct for errors that are not independently and identically distributed and the independent variables were averaged, to correct for missing completely at random (MCAR) data. Variance Inflation Factors were computed to check for multicollinearity in the model. Data was also sourced from well renowned organisations' databanks.

There are several limitations to this study. First, the lack of comprehensive macro data for the Human Capital Index (HCI), which is an index that calculates the contribution of health and education to productivity, for the sample countries, a lack of mean years of schooling in Africa data and a lack of complete government expenditure on education data for countries in the sample was a deterrent to researching the said topic comprehensively in Africa. Also, the relatively short time span of my data may have contributed to the inconclusiveness of the estimates. Though, there is no way to increase the observed time period without changing the corruption indicator to a less suitable index or measure.

Furthermore, corruption is very complex problem in Africa. As such its influence on human capital convergence may be indirect through variables that were not considered in this study. This might be a reason for the statistically insignificant estimates. Corruption data may be much more

efficient as microdata, affecting provinces and states in the countries; this might create a more hands-on way to analyse the topic. I recommend future research on this topic in Africa to question these indirect influences. During this research, I attempt to cluster the corruption levels by using a dummy variable, I use the original corruption variable, use an interaction term, change the dependent variable to education, I use robust standard errors, attempt changing the time interval length and attempt various variables seen in non-African studies, yet the results show statistical insignificance for most of the estimates. I recommend that future studies to focus on using primary data surveys or experimental approaches to investigate the subject. Despite these limitations, the data are a representative sample and therefore have the potential to inform policy and programming recommendations.

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Table 1: Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
lnHDI	350	-.449	.249	-1.085	-.063
lnCPI	340	3.307	1.058	-3.584	4.477
lnPOP	350	.742	.599	-2.909	1.48
lnSAV	310	2.882	.593	-.483	4.086
lnINEQ	350	-.528	.122	-.973	-.13

Table 2: Between and within variation

Variable		Mean	Std. Dev.	Min	Max	Observations
lnHDI	overall	-.4491667	.2488172	-1.084709	-.0629398	N = 350
	between		.2495757	-1.025915	-.0695156	n = 50
	within		.0263216	-.5632083	-.2275952	T = 7
lnCPI	overall	3.30743	1.058376	-3.583519	4.477337	N = 340
	between		1.05169	-3.554874	4.133662	n = 50
	within		.1098046	2.467476	3.857303	T-bar = 6.8
lnPOP	overall	.7422991	.5987432	-2.908688	1.480436	N = 350
	between		.5799282	-2.07396	1.393166	n = 50
	within		.1672083	-.1699893	1.597134	T = 7
lnSAV	overall	2.881658	.5934888	-.4827675	4.085859	N = 310
	between		.5365664	1.53405	3.718984	n = 46
	within		.2819867	.8648411	3.803605	T-bar = 6.73913
lnINEQ	overall	-.5275139	.1216013	-.9728611	-.1301087	N = 350
	between		.1094941	-.7758611	-.3033878	n = 50
	within		.0548092	-.9246677	-.0819153	T = 7

Where “n” is the number of countries, “T” is the number of time periods and “N” = nT

Table 3: Pooled OLS Estimates of Human capital convergence

VARIABLES	(1) HDIdiff	(2) HDIdiff	(3) HDIdiff
HDIlag	-0.0127**	-0.0127**	-0.00867
	(0.00513)	(0.00586)	(0.00581)
HC	0.00402	0.00402	0.000482
	(0.00266)	(0.00314)	(0.00266)
β_1*HC			-0.00784
			(0.00870)
SAVbar	0.000472	0.000472	0.000879
	(0.00223)	(0.00286)	(0.00298)
POPbar	0.00123	0.00123	0.00125
	(0.00209)	(0.00125)	(0.00136)
INEQbar	-0.0293***	-0.0293	-0.0289
	(0.0110)	(0.0176)	(0.0174)
Constant	-0.0179*	-0.0179	-0.0174
	(0.00969)	(0.0179)	(0.0176)
Observations	133	133	133
R-squared	0.114	0.114	0.118
F-Stat	3.272	3.396	3.351
Prob > F	0.00818	0.0109	0.00816
Degree of Freedom	127	45	45

Notes: Dependent variable is ln HDI_t - ln HDI_{t-2}. Standard errors in parentheses. Columns 2 and 3 have been treated with robust standard errors. * indicates the level of significance at 10%, ** indicates the level of significance at 5% and *** indicates the level of significance at 1%

Table 4: Multicollinearity Test

	VIF	1/VIF
HDIlag	1.176	.85
HC	1.153	.867
SAVbar	1.09	.918
POPbar	1.082	.924
INEQbar	1.058	.945
Mean VIF	1.112	.

VIF means "Variance Inflation Factor", a diagnostic test for the presence of multicollinearity.

Table 5: Pooled OLS Estimates of Human capital convergence

VARIABLES	(1) HDIdiff	(2) HDIdiff	(3) HDIdiff
HDIlag	-0.0147***	-0.0147**	-0.0148**
	(0.00495)	(0.00692)	(0.00706)
CPIbar	0.00109	0.00109	
	(0.00118)	(0.000831)	
SAVbar	0.000209	0.000209	-0.000182
	(0.00219)	(0.00286)	(0.00259)
POPbar	0.00206	0.00206*	0.00219
	(0.00200)	(0.00113)	(0.00131)
INEQbar	-0.0322***	-0.0322*	-0.0284*
	(0.0116)	(0.0192)	(0.0169)
Very high corruption			-0.00143
			(0.00219)
Constant	-0.0224*	-0.0224	-0.0154
	(0.0119)	(0.0213)	(0.0161)
Observations	137	137	133
R-squared	0.103	0.103	0.100
F-Stat	3.021	4.553	3.970
Prob > F	0.0129	0.00192	0.00456
Degree of Freedom	131	45	45

Notes: Dependent variable is ln HDI_t - ln HDI_{t-2}. Standard errors in parentheses. Columns 2 and 3 have been treated with robust standard errors. * indicates the level of significance at 10%, ** indicates the level of significance at 5% and *** indicates the level of significance at 1%

Table 6: Pooled OLS Estimates of Convergence in Education

VARIABLES	(1) EDUdiff	(2) EDUdiff
EDUClag	-0.516***	-0.516***
	(0.0508)	(0.0483)
HC	-0.0396	-0.0396
	(0.0347)	(0.0380)
SAVbar	-0.0220	-0.0220
	(0.0292)	(0.0280)
INEQbar	-0.0902	-0.0902
	(0.142)	(0.159)
POPbar	0.00974	0.00974
	(0.0275)	(0.0170)
Constant	-0.387***	-0.387***
	(0.120)	(0.138)
Observations	88	88
R-squared	0.576	0.576
F-Stat	22.31	27.44
Prob > F	0	0
Degree of Freedom	82	45

Notes: Dependent variable is Education; ln $EDUC_t$ - ln $EDUC_{t-2}$. Standard errors in parentheses. Column 2 has been treated with robust standard errors. * indicates the level of significance at 10%, ** indicates the level of significance at 5% and *** indicates the level of significance at 1%

Table 7: OLS Estimates of Human capital convergence (Collapsed Cross-sectional Data)

VARIABLES	(1) ln HDI_{2018} - ln HDI_{2012}	(2) ln HDI_{2018} - ln HDI_{2012}	(3) ln HDI_{2018} - ln HDI_{2012}
HDIlag	-0.0881***	-0.0881**	-0.0905*
	(0.0300)	(0.0413)	(0.0470)
lnCPI	0.00742	0.00742	
	(0.00737)	(0.00552)	
lnSAV	0.00217	0.00217	-0.00139
	(0.0143)	(0.0178)	(0.0151)
lnPOP	0.00886	0.00886	0.00973
	(0.0127)	(0.00658)	(0.00833)
lnINEQ	-0.204***	-0.204	-0.179
	(0.0744)	(0.124)	(0.109)
HC			-0.0100
			(0.0172)
Constant	-0.144*	-0.144	-0.0939
	(0.0756)	(0.135)	(0.0980)
Observations	46	46	46
R-squared	0.262	0.262	0.250
F-Stat	2.844	3.908	3.392
Prob > F	0.0274	0.00560	0.0120
Degree of Freedom	40	40	40

Notes: Dependent variable is ln HDI_{2018} - ln HDI_{2012}. Standard errors in parentheses. Columns 2 and 3 have been treated with robust standard errors. * indicates the level of significance at 10%, ** indicates the level of significance at 5% and *** indicates the level of significance at 1%.

APPENDIX

Table A1: List of Variables

Variables	Original Sources
Human Development Index (HDI)	United Nations Development Programme: Human development report databank.
Population growth rate (Annual)	World Bank: World Development Indicators
Corruption Perception Index (CPI) (ranging from "0" to "100"	Transparency International
Gini coefficient (Income Inequality)	World Inequality Database
Gross savings (% of GDP)	World Bank: World Development Indicators
Education Index	United Nations Development Programme: Human development report databank.

Source: Author's compilation

Table A2: Corruption clusters

Relatively Low corruption countries	Relatively High corruption countries
Benin	Algeria*
Botswana	Angola*
Burkina Faso	Burundi*
Cabo Verde	Cameroon
Djibouti	Central African Republic*
Egypt	Chad*
Ethiopia	Comoros
Gabon	Democratic Republic of Congo*
Gambia	Congo Republic*
Ghana	Equatorial Guinea*
Lesotho	Guinea*
Malawi	Kenya
Mauritania	Madagascar
Mauritius	Mozambique
Morocco	Nigeria
Namibia	South Sudan*
Niger	Uganda
Rwanda	
Senegal	
Seychelles	
Sierra Leone	
South Africa	
Tanzania	
Togo	
Tunisia	
Zambia	

* identifies countries in the top 25 percent with respect to the corruption perception index.

Source: Author's compilation