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NATURAL RESOURCE RENTS, HUMAN CAPITAL AND ECONOMIC GROWTH IN WEST AFRICA: EVIDENCE FROM DRISCOLL–KRAAY AND PANEL KERNEL REGULARISED LEAST SQUARES ESTIMATION

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Abstract

Motivated by the persistent paradox of abundant natural resource endowments coexisting with weak economic performance in West Africa, this study examines whether natural resource rents constrain economic growth in the region, and whether human capital operates as a countervailing force. Using annual panel data for eight West African countries (Benin, Burkina Faso, Côte d'Ivoire, Ghana, Niger, Nigeria, Senegal and Togo) over 1990–2024, the study estimates a growth model derived from endogenous growth theory in which natural resource rents and human capital are modelled alongside energy productivity, physical capital and globalisation. Preliminary diagnostics confirmed serial correlation, heteroscedasticity and cross-sectional dependence, while the Westerlund error-correction-based test found no evidence of panel cointegration. The Driscoll–Kraay fixed-effects (DK-FE) estimator was therefore adopted as the baseline technique, complemented by the panel Kernel Regularised Least Squares (KRLS) approach to capture nonlinear and heterogeneous effects. The DK-FE results show that natural resource rents exert a negative but statistically insignificant effect on GDP, whereas the

KRLS estimates reveal a negative and highly significant average effect that persists across the conditional distribution, lending robust support to the resource curse hypothesis. Human capital, by contrast, is found to be a strong, positive and highly significant driver of growth under both estimators. The findings suggest that the growth-retarding effects of resource dependence in West Africa are structurally embedded, while investment in education and skills offers a reliable pathway to sustainable growth. The paper recommends strengthened natural resource governance, transparent revenue management, economic diversification, and sustained investment in human capital.

Keywords: Natural Resource Rents; Resource Curse; Human Capital; Economic Growth; West Africa; Driscoll–Kraay; Kernel Regularised Least Squares

INTRODUCTION

West Africa has a lot of natural resources, like oil, gas, gold, and diamonds, and a lot of good land for farming. Nigeria is the top oil producer in Africa, while Ghana is a big exporter of gold and cocoa. Côte d'Ivoire is the largest producer of cocoa in the world, and Senegal is becoming a major player in the oil and fishing industries. The money made from selling these natural resources, after subtracting the costs of extracting them, is a good indicator of how wealthy a country is in terms of resources. This money could be used to fund important things like roads, schools, and industries, which would help the country develop and change its economy.

In practice, however, many West African economies illustrate the so-called "resource curse": despite vast natural endowments, the region remains among the least industrialised and lowest-income in the world, with persistent energy poverty and GDP per capita consistently below both Sub-Saharan African and global averages (Auty, 1993; Sachs & Warner, 2001; Ploeg, 2011). Three interlinked mechanisms are commonly implicated: revenue volatility arising from fluctuating global commodity prices, which exposes resource-dependent economies to fiscal and external shocks (Saadaoui & Jbir, 2021); Dutch disease effects, whereby resource export revenues appreciate the real exchange rate and erode the competitiveness of manufacturing and agriculture (Khan et al., 2023); and rent-seeking behaviour that diverts public funds away from productive investment in education, infrastructure and technology (Hassan et al., 2025).

The impact of resource rents on growth is a complex issue that depends on various domestic factors, particularly the quality of institutions and the stock of human capital. When a country has strong institutions and can efficiently reinvest its resource revenues, it can convert its natural wealth into industrial and human capital growth, as seen in studies by Khan et al. (2022), Hidayat et al. (2024), and Kadir et al. (2024). On the other hand, a skilled workforce is

essential for enhancing the absorptive capacity of an economy, supporting diversification away from primary commodities, and mitigating the adverse effects of resource dependence by strengthening institutional quality and innovation, as noted by Gylfason (2001) and Bravo-Ortega & De Gregorio (2005). However, despite the importance of this interaction, there is a lack of empirical evidence on West Africa, with many studies focusing on single-country analyses, such as Gyimah et al. (2022), or pooling West African economies with other regions, which can mask the unique structural characteristics of the region, including commodity dependence, weak energy infrastructure, and exposure to global price shocks, as highlighted by Alola et al. (2022), Osabohien et al. (2024), and Kadir et al. (2024). Furthermore, much of the existing literature overlooks the cross-sectional dependence and heterogeneity that characterize integrated regional economies, which can lead to biased inference, as cautioned by Pesaran (2006) and Eberhardt & Teal (2011). In order to better understand the relationship between resource rents and growth in West Africa, it is essential to conduct more comprehensive and nuanced studies that take into account the region's unique characteristics and the complex interactions between institutions, human capital, and resource dependence. By doing so, policymakers and researchers can gain a deeper understanding of the factors that drive growth and development in the region and develop more effective strategies for promoting sustainable and inclusive economic growth. Ultimately, the goal should be to create a more favorable environment for economic growth and development in West Africa, one that is characterized by strong institutions, a skilled workforce, and a diversified economy that is less dependent on primary commodities.

This study helps fill in the gaps by looking at how natural resource rents and human capital affect economic growth in eight West African countries from 1990 to 2024. It uses a special framework that takes into account differences between countries, patterns over time, uneven data, and possible non-linear relationships. The rest of the study is laid out like this: Section 2 looks at what other researchers have said about this topic. Section 3 explains how we did our research. Section 4 shows what we found. Section 5 talks about what our findings mean in relation to what other researchers have said. And Section 6 sums up what we learned and suggests some policies based on our results.

LITERATURE REVIEW

Theoretical Framework

Economic growth in the long run is driven by things that happen inside the economy, like investing in people's skills and knowledge, doing research, and creating new ideas. This is based on the Endogenous Growth Theory, which was talked about by Romer in 1990 and Lucas

in 1988. They said that growth doesn't just come from new technology that comes from outside the economy, but from things that people and businesses do on purpose to make the economy grow. The basic model for this can be written down in a simple way, which is often called the canonical endogenous growth model.

$$Y_{it} = A_{it}K_{it}^{\alpha}H_{it}^{\beta}L_{it}^{1-\alpha-\beta} \quad (1)$$

Let's break it down in simpler terms. We're looking at how different factors like physical capital, human capital, labor, and technology affect the output of a country. The idea is that technological progress isn't just something that happens by chance, but rather it's the result of deliberate decisions made by policymakers. In countries with a lot of natural resources, like those in West Africa, the money made from these resources can be used to improve things like education, research, and infrastructure, which can then increase productivity. However, if this money is not managed well, it can actually have the opposite effect and decrease productivity. To study this, researchers use certain measures like natural resource rents, energy productivity, human capital, and a globalization index to estimate how these factors impact growth. This approach allows us to see how the "resource curse" - where having a lot of natural resources actually hurts a country's economy - fits into a broader picture of productivity. So, basically, we're trying to understand how different factors interact to affect a country's growth, and how policymakers can make informed decisions to promote technological progress and increase productivity. This is important because it can help countries, especially those with a lot of natural resources, to use their resources effectively and achieve sustainable economic growth. The key is to find the right balance and make sure that the wealth generated from natural resources is invested in ways that will benefit the country in the long run, such as in education, research, and infrastructure. By doing so, countries can avoid the negative effects of the "resource curse" and instead use their resources to drive economic growth and improve the lives of their citizens. It's a complex issue, but by studying the relationships between these different factors, researchers can provide valuable insights that can help policymakers make better decisions and promote sustainable economic growth.

Empirical Literature and the Resource Curse Debate

A lot of research shows that having a lot of natural resources can actually hurt a country's economy. Some important studies by Sachs and Warner in 1995 and 2001 found that countries with a lot of resources tend to grow slower than those with fewer resources. Later studies looked closer at this and found some reasons why this might happen. For example, Frankel in 2012 and Ross in 2015 said that when a country's income from resources goes up and down a lot, it can cause problems like Dutch disease and poor governance. Another study

by El-Anshasy and Katsaiti in 2013 found that in some Middle Eastern and North African countries, the money from oil actually made the economy grow slower because the institutions were weak. And more recently, Adom and Adams in 2020 found that in West Africa, relying too heavily on natural resources can make it harder for countries to grow in the long run and can even reduce their energy productivity.

There's a different view on how natural resources affect a country's growth. Some researchers found that when a country has good institutions, its natural resources can actually help it grow. For example, a study by Mehlum and others in 2006 showed that natural resources can boost growth in countries with strong institutions. Another study by Lewin in 2011 found that Botswana's diamond wealth had a positive impact because the country managed its finances wisely. More recent studies, like the one by Hassan and others in 2025, found that natural resources can promote growth in developed and emerging economies if they are combined with technological progress and good governance. Similarly, a study by Khan and others in 2022 reported positive effects in developing economies that used their natural resources to diversify their economies and develop their human capital. This suggests that whether natural resources help or hurt a country's growth depends on the country's internal strengths and institutions, rather than the resources themselves.

Education and skills are key to long-term growth, and this idea is backed up by a lot of evidence. For example, studies by Barro and Hanushek and Woessmann found that how well-educated people are and how skilled they are have a big impact on how well countries grow. In Africa, researchers like Anyanwu and Adu have shown that investing in human capital can lead to higher productivity and growth in countries like Nigeria and Ghana. However, some studies also suggest that just increasing education isn't enough - the quality of education and the support of institutions also matter. Pritchett found that if the quality of education is low, just expanding access to education won't necessarily lead to more growth. Similarly, Gyimah-Brempong and others found that in Sub-Saharan Africa, the link between human capital and growth depends on how well-governed a country is. So, while human capital is important, it's not a magic bullet - it needs to be combined with other factors to really drive growth.

Gap in the Literature

This study looks at how natural resources and people's skills affect growth in West Africa. While we know a lot about how resources can hurt a country's economy and how important it is to invest in people's skills, not many studies have looked at both things together in a specific region like West Africa. This paper tries to fill that gap by using special methods that can handle complex relationships between different factors and differences between countries.

METHODOLOGY

Research Design and Model Specification

This research uses a quantitative approach with panel data to account for differences between countries that don't change over time, making the estimates more efficient than if we just looked at data from one point in time or over a short period. By doing this, we can get a better understanding of what's going on. The model we're using is based on work by other researchers, like Yıldırım and Baycan, and Hidayat et al., and it looks like this:

$$GDP_{it} = \beta_0 + \beta_1 nr_{it} + \beta_2 ep_{it} + \beta_3 kp_{it} + \beta_4 hc_{it} + \beta_5 gi_{it} + \varepsilon_{it} \quad (2)$$

Here's a rewritten version of the input text in a more human-like tone, similar to the provided reference human samples: When we look at a country's economy, there are several factors that can affect its growth. We can measure a country's economic growth by looking at its real GDP per capita, which is the total amount of goods and services produced within a country, divided by the number of people living there. We also need to consider other important factors such as natural resource rents, which is the money earned from selling a country's natural resources, like oil or gas. Another key factor is energy productivity, which is how efficiently a country uses energy to produce goods and services. We can break down energy productivity into two parts: renewable energy, like solar or wind power, and non-renewable energy, like coal or oil. Physical capital, which includes things like buildings, machines, and equipment, is also crucial for a country's economic growth. Additionally, human capital, which refers to the skills, education, and experience of a country's workforce, plays a significant role. Globalisation, or the integration of a country into the global economy through trade, investment, and technology transfer, is another important factor. In this study, we're focusing on two specific factors: natural resource rents and human capital. We want to understand how these factors affect a country's economic growth, while also considering the impact of energy productivity, physical capital, and globalisation. By examining these relationships, we can gain a better understanding of what drives economic growth and how countries can work to improve their economies.

Data

This study looks at a group of countries in West Africa, including Benin, Burkina Faso, Côte d'Ivoire, Ghana, Niger, Nigeria, Senegal, and Togo, over a period of 34 years, from 1990 to 2024. The data used for the analysis comes from different sources: the World Bank's World Development Indicators, which provides information on GDP per capita, natural resource rents, and the globalization index, and the Penn World Table, which has data on human capital. Additionally, for Nigeria, some data on gross fixed capital formation was taken from the Central Bank of Nigeria Statistical Bulletin. The time frame and the countries included in the study were

chosen based on the availability of data. In total, the analysis is based on 280 observations, each representing a country in a specific year.

Estimation Procedure

To figure out the relationships between different economic factors, the estimation is done using E-views 12 and Stata 16 software. We did our analysis in three main steps. First, we looked at the basic numbers and how they relate to each other to understand the data better and make sure we weren't counting the same things multiple times. We used some statistical tools to check for this. Next, we checked if the numbers were affected by things that happened before or if they were unevenly spread out. We also looked at how connected the economies of West Africa are, since they work closely together. Finally, because we found that these economies are indeed connected, we used some special tests to see how they move together over time and if they tend to balance each other out in the long run. These tests help us understand if the economies are growing together in a stable way.

When we can't find a long-term relationship between variables, we can't use certain methods like FMOLS, DOLS, and CCR to estimate them. Instead, we focus on short-term changes and use methods that can handle problems like correlated data, serial correlation, and uneven variance. One such method is the Driscoll and Kraay fixed-effects estimator, which we used as our main technique. This method extends the HAC covariance estimator to panel data, correcting for cross-sectional dependence, serial correlation, and heteroscedasticity all at once, without needing to find a long-term relationship. To make sure our results are robust, we also used the panel Kernel Regularised Least Squares estimator, which doesn't assume a specific relationship between variables and can estimate the effects of variables at different points in the distribution of the outcome. This makes it useful for detecting non-linear and heterogeneous relationships that a linear model might miss. By using these methods, we can get a better understanding of the short-term dynamics at play.

RESULTS

Descriptive Statistics and Preliminary Diagnostics

Table 1 reports the descriptive statistics for the variables used in the model. Mean GDP per capita (logged) is 6.87, while natural resource rents (NR) average 1.22 with a standard deviation of 1.80, indicating substantial variation in resource dependence across countries and time. Human capital (HC) averages 0.27, with a standard deviation of 0.46. The Jarque–Bera statistics indicate that most variables, including GDP and NR, depart significantly from

normality, motivating the use of distribution-robust and nonlinear estimation methods such as KRLS alongside the linear DK-FE baseline.

Table 1. Descriptive Statistics

Statistic	GDP	NR	KP	HC	GI
Mean	6.874	1.224	2.915	0.274	3.811
Median	6.874	1.713	2.913	0.338	3.846
Maximum	7.858	3.534	3.566	0.978	4.129
Minimum	5.806	-3.934	2.001	-0.944	3.261
Std. Dev.	0.539	1.798	0.332	0.463	0.186
Skewness	-0.064	-1.764	-0.206	-1.210	-0.646
Jarque–Bera	11.445	194.468	2.197	79.255	19.496
Probability	0.003	0.000	0.333	0.000	0.000
Observations	280	280	280	280	280

Source: Authors' computation using E-views 12. Renewable and non-renewable energy productivity (RP, NP) statistics are reported in the companion paper.

The data was calculated by the authors using E-views 12, and it's worth noting that the statistics for renewable and non-renewable energy productivity, which are referred to as RP and NP, can be found in a separate paper that accompanies this one.

The connection between two things, like NR and GDP, is pretty strong, with a correlation of 0.463 - this means when one goes up, the other tends to go up too. On the other hand, HC doesn't seem to have much of a direct relationship with GDP, with a correlation of -0.028, which is almost zero. This suggests we need to look at how all these things interact with each other, not just one on one. We also checked for multicollinearity, which is when two or more things are so closely related that it's hard to tell them apart. The VIF test showed that this isn't a problem, with an average VIF of 1.59 and no individual values above 2.2 - well below the threshold of 5 where we start to worry.

Diagnostic testing confirms that all three key panel data issues are present. The Wooldridge test rejects the null of no first-order serial correlation ($F(1,7) = 60.448$, $p = 0.000$). The Breusch–Pagan/Cook–Weisberg test rejects homoscedasticity ($\chi^2 = 8.89$, $p = 0.003$). The Pesaran CD tests reject cross-sectional independence for GDP, HC and most other variables. Panel unit root tests (CIPS and CADF) indicate a mixed order of integration, with most series—including NR and HC—stationary only in first differences, while the Westerlund (2007) error-correction-based cointegration test fails to reject the null of no cointegration (asymptotic and

bootstrap-robust p-values all exceeding 0.68 across the Gt, Ga, Pt and Pa statistics). Taken together, these results confirm that the DK-FE estimator, complemented by panel-KRLS, is the appropriate estimation strategy.

Driscoll–Kraay Fixed-Effects Results

When we look at the numbers, we can see how different factors affect economic growth. For example, relying too much on natural resources doesn't seem to have a big impact on growth. In fact, the numbers show that it doesn't really matter one way or the other. On the other hand, human capital - which means the skills and knowledge people have - is really important. If we can improve human capital by just 1%, it can lead to a growth of almost 0.84% in the average income of a country. Other things that can help growth are being more efficient with energy and being more connected to the global economy. However, having a lot of physical capital, like machines and buildings, doesn't always lead to more growth. Sometimes, it can even be a waste if not used properly. Overall, our model can explain about 76% of why some countries are richer than others. This means we're on the right track to understanding what helps economies grow. The numbers are clear: investing in people's skills and knowledge, and being smart about how we use energy and work with other countries, can make a big difference.

Table 2. Driscoll–Kraay Standard Errors with Fixed Effects

Variable	Coefficient	DK Std. Err.	t	P>|t|	95% CI
NR	-0.006	0.017	-0.35	0.729	[-0.040, 0.028]
HC	0.844	0.147	5.76	0.000	[0.547, 1.142]
KP	-0.151	0.238	-6.34	0.000	[-0.199, -0.102]
GI	0.774	0.118	6.58	0.000	[0.535, 1.013]
Constant	4.245	0.387	10.96	0.000	[3.458, 5.032]

Source: Authors' computation using Stata 16. Obs. = 280; Groups = 8; R^2 = 0.76; F-test p = 0.000. Full model includes renewable and non-renewable energy productivity, reported in the companion paper.

We did some calculations using a special computer program called Stata 16. We looked at 280 observations, which we divided into 8 groups. Our results showed a strong relationship between the variables, with an R^2 of 0.76. We also did a special test called an F-test, which showed that our results were statistically significant, with a p-value of 0.000. Our full model included data on renewable and non-renewable energy productivity, which is discussed in more detail in a separate paper.

Panel-KRLS Robustness Results

Let's take a closer look at the results in Table 3, which shows how different factors affect the economy. What's really interesting here is that when we look at how natural resources impact the economy, we see a big negative effect - on average, it's -0.095, which is highly significant. This negative effect is seen across the board, whether we're looking at the lower, middle, or upper ranges of the economy. This suggests that relying too heavily on natural resources can actually hurt economic growth, and this effect is consistent across different parts of the economy. On the other hand, investing in human capital - things like education and training - has a really positive effect on the economy. On average, we see a strong positive effect of 0.315, which is also highly significant. What's more, this positive effect gets even bigger as we move up the economic ladder - at the lower end, the effect is 0.033, but at the upper end, it's a whopping 0.612. This suggests that investing in human capital can have big payoffs, especially at higher levels of educational attainment. Overall, these results suggest that investing in human capital is a key way to drive economic growth, while relying too heavily on natural resources can actually hold us back.

Table 3. Panel-KRLS Estimates

Variable	Average	Std. Err.	t	P>|t|	P25	P50	P75
NR	-0.095	0.008	-11.920	0.000	-0.170	-0.095	-0.028
HC	0.315	0.019	16.432	0.000	0.033	0.300	0.612
KP	0.058	0.024	2.383	0.018	-0.146	0.075	0.250
GI	0.729	0.053	13.621	0.000	0.364	0.781	1.105

Source: Authors' computation using Stata 16. R^2 = 0.98; λ = 0.176; effective d.f. = 47.19; leave-one-out loss = 5.631; F-test p = 0.000. Obs. = 280.

The results were calculated by the authors using Stata 16. The findings show a strong correlation, with an R^2 value of 0.98. Other key statistics include a lambda value of 0.176, effective degrees of freedom at 47.19, and a leave-one-out loss of 5.631. The F-test p-value is 0.000, indicating statistical significance. The analysis is based on 280 observations.

Model diagnostics confirm a strong and well-fitted specification: the KRLS R^2 of 0.98 indicates that the model explains 98% of the variation in GDP per capita, the regularisation parameter (λ = 0.176) indicates limited penalisation, allowing the model to flexibly capture nonlinearities, and the leave-one-out loss of 5.631 indicates good out-of-sample predictive performance.

DISCUSSION

Natural Resource Rents and the Resource Curse in West Africa

The difference between the DK-FE and KRLS results is actually very helpful. It shows that the average linear effect is not significant under DK-FE, but the effect is significant and negative across the conditional distribution under KRLS. This means that the resource curse in West Africa is a complex issue that can't be explained by a simple linear average. It's a nonlinear phenomenon that is deeply embedded in the structure of the economy. This is in line with what other researchers have found. For example, Auty (1993), Sachs and Warner (2001), and Ploeg (2011) have all shown that the resource curse is a real issue. If we look at specific countries, we can see that the resource curse is a big problem. In Nigeria, for instance, oil revenues have mostly been used for recurrent expenditure, fuel subsidies, and rent-seeking, rather than being invested in important areas like manufacturing, education, or infrastructure. This has left the economy vulnerable to boom-bust cycles, like the 2014-2016 oil price collapse. Similarly, in Niger, the country's uranium wealth has not been able to generate much economic growth because of weak institutions and limited human capital. In Ghana and Burkina Faso, gold and cocoa revenues have also not been able to drive broad-based industrial development. So, it's clear that the resource curse is a real issue in West Africa, and it's not just a simple problem that can be explained by a linear average. It's a complex, nonlinear phenomenon that requires a more nuanced understanding. The fact that the KRLS results show a significant and negative effect across the conditional distribution suggests that the resource curse is a structural issue that is embedded in the economy. It's not just a matter of a simple linear average, but rather a complex issue that requires a more detailed analysis. This has important implications for policymakers, who need to understand the complex dynamics of the resource curse in order to develop effective strategies for managing natural resources and promoting economic development. In conclusion, the difference between the DK-FE and KRLS results is very informative, and it highlights the importance of using nonlinear models to understand the complex dynamics of the resource curse in West Africa. By examining the conditional distribution of the effects, we can gain a deeper understanding of the structural issues that underlie the resource curse, and develop more effective strategies for promoting economic development in the region.

The discovery actually supports the idea that having a lot of natural resources can be beneficial when a country has good leadership and institutions. For example, Botswana's economy grew because of its diamonds, and studies by Mehlum et al. and Hassan et al. found that natural resources can have a positive impact on well-governed economies. This means that whether or not natural resources help a country's economy grow depends on the situation,

rather than being a fixed rule. The fact that natural resources seem to be hurting the economy in West Africa is likely due to the region's problems with governance and diversification, rather than the natural resources themselves. To fix this, it's essential to have stronger institutions, transparent management of revenue, and investments in areas that can increase productivity, as suggested by experts like Frankel, Ross, and Khan.

Human Capital as a Driver of Growth

Economic growth in West Africa is driven by a key factor: human capital. This is a consistent and significant finding, and its importance is growing. It doesn't matter if we look at the numbers in a simple or complex way - the result is the same. This makes sense, given what we know about how knowledge and experience can lead to long-term economic growth. Many studies have shown this to be true, including those by Lucas, Romer, Barro, and Hanushek and Woessmann. If we look at specific countries, we can see this pattern playing out. In Ghana and Senegal, for example, improvements in education have led to a stronger link between the quality of the workforce and the transformation of the economy. On the other hand, countries like Niger and Burkina Faso are still struggling with limited education and its negative impact on productivity and technology. However, it's not just about getting more people in school - the quality of education and the support of institutions are crucial. As Pritchett, Gyimah-Brempong, and Oketch have noted, simply increasing enrollment is not enough. We need to make sure that the education system is working well and that students are getting the support they need to succeed.

When you look at the results together, they show that human capital is the main thing that helps balance out the resource curse in West Africa. This means that when a country has a skilled workforce, its economy is better able to absorb new technology, move away from relying too much on primary commodities, and turn resource revenue into productive investments - but only if the resources are managed properly.

CONCLUSION AND POLICY RECOMMENDATIONS

This study looks at how money from natural resources and people's skills affect a country's economy in eight countries in West Africa from 1990 to 2024. It uses a special way of analyzing data that accounts for differences between countries, patterns over time, and uneven spreads of data. The results show that, on average, natural resources don't seem to have a big impact on economic growth. However, when looking closer, it's clear that natural resources actually hurt economic growth, which is known as the "resource curse." On the other hand,

people's skills and education are a strong and reliable driver of economic growth, and this effect gets even stronger over time.

When it comes to managing natural resources, there are a few key things that West African governments should keep in mind. For one, they need to make sure they have strong institutions in place to oversee how the money from these resources is being used. This means being transparent about how the funds are being managed, and putting rules in place to prevent excessive spending when the economy is doing well. It's also important for these governments to diversify their economies, so they're not relying too heavily on one or two industries. By investing in areas like manufacturing, agriculture, and technology, they can create more stable and sustainable growth. And finally, it's crucial to prioritize education and job training, so that people have the skills they need to succeed in these new industries. This will not only help the economy grow in the long run, but also reduce the negative effects of relying too heavily on natural resources.

These findings and recommendations should, however, be read alongside three limitations of the study. First, the use of panel data required variables to be strictly comparable across the eight countries, yet national statistical offices in West Africa apply divergent definitions and methodologies for measuring resource rents and human capital; harmonising these introduces a degree of measurement error that a single-country study could have avoided by tailoring variables more precisely. Second, although techniques such as Driscoll-Kraay estimation and bootstrapped cointegration were applied to address cross-sectional dependence, these methods rely on a sufficiently large time dimension or on strong underlying assumptions, an issue a country-specific analysis would not face at all. Third, because the sample is confined to West Africa, the findings are specific to this sub-region; while the conclusions may plausibly transfer to other African sub-regions with comparable institutional and economic structures, this generalisability has not been tested directly.

Further research could help address these limitations directly — for instance, by combining the panel evidence here with single-country case studies to cross-check the harmonised variables, or by extending the analysis to other African sub-regions to test how far the resource-curse and human-capital findings actually generalise. Such work would help policymakers better understand how to make the most of natural resources, and how to avoid the pitfalls that can come with relying on them.

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