Do Natural Resource Endowments Affect Export Diversification in Africa? A Cross-Country Analysis

Dieynaba Niass

Research Paper 558

Bringing Rigour and Evidence to Economic Policy Making in Africa

AFRICAN ECONOMIC RESEARCH CONSORTIUM
CONSORTIUM POUR LA RECHERCHE ÉCONOMIQUE EN AFRIQUE

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AERC Research Paper 558
African Economic Research Consortium, Nairobi
April 2024

THIS RESEARCH STUDY was supported by a grant from the African Economic Research Consortium. The findings, opinions and recommendations are those of the author, however, and do not necessarily reflect the views of the Consortium, its individual members or the AERC Secretariat.

Published by: The African Economic Research Consortium
P.O. Box 62882 - City Square
Nairobi 00200, Kenya

ISBN 978-9966-61-263-2

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Abstract

This paper aims to analyse the effect of natural resources on the supply portfolio of African exports. Based on COMTRADE data on export products from 2000–2015, a methodological approach is applied using two standard measurement trade diversification indicators: active line counting and the standardised Herfindahl-Hirschman index. These indicators are then linked to the status of resource-rich countries (and other controls) in a fixed-effects panel data model. The results of this paper suggest that the presence of oil resources (non-renewable resources) hurts diversification, essentially through the channel of degradation of institutions. Similarly, agricultural products (renewable resources) negatively affect African export diversification (count and index) through the exchange rate channel. This shows the need for Africa to strengthen the quality of institutions by fighting against corruption through transparency in the exploitation and export of natural resources, and through proper management. In addition, African countries must ensure the stability of monetary policies so that a depreciation of the exchange rate can be to their advantage.

Key words: diversification, natural resources, panel data, export diversification, Africa

JEL Codes: F13 ; Q32 ; C33

1. Introduction

The effect of natural resources on the diversification of countries' export baskets has been the subject of many studies. Several authors have shown that an abundance of resources is a source of diversification and, therefore, of economic development (Wright and Czelusta, 2002a and 2002b; Canuto and Cavallari, 2012; Oyinlola et al., 2015; Hannan and Mohsin, 2015; Yanikkaya and Turan, 2018). However, another strand of the economic literature indicates a negative relationship between resource abundance and the economic performance of countries, thereby evoking the phenomenon of the paradox of abundance or the resources natural curse (Sachs and Warner, 1995 and 2001; Auty, 2001; Behbudi et al., 2010; James and Aadland, 2011; Kim and Lin, 2017), which can be captured by the exchange rate channel and the quality of institutions.

Some empirical research has been conducted in the countries investigated to demonstrate this negative relationship, which can be explained by different channels. It has been shown that resource-rich countries often have very low-level institutions (Devarajan, 2019; Bakwena et al. 2010; Caselli and Michaels, 2013; Mideksa, 2013; Badeeb et al., 2017). In addition, other authors such as Bresser-Pereira (2008, 2013, 2017) and Bahar and Santos (2018) have suggested that the appreciation of the real exchange rate due to the exploitation of cheap and abundant natural resources, which causes Dutch disease, may be a mechanism that can explain this phenomenon. Therefore, empirically understanding how these different channels could help explain the potential effect of natural resources on countries' exports in the specific context of Africa is undoubtedly of major political interest, given the inability of African countries to benefit from globalisation.

Africa's large natural endowments may suggest they negatively affect the possibility of diversifying trade. To investigate this, we formulate the following question: Is the abundance of natural resources a hindrance to the diversification of African economies? The overall objective of this study is to analyse the effect of natural resources on the diversification of Africa's export supply portfolio. Specifically, it involves first measuring the extent of diversification or the concentration of exports in terms of product variety, then analysing the effect of natural resources on the diversification of African exports, and, finally, identifying possible channels through which natural resources would affect the supply portfolio of African exports. To achieve these research objectives, we formulate the following hypotheses: First, Africa has a

relatively concentrated export basket of basic products. Second, natural resources negatively affect the diversification of Africa's export supply portfolio, and, finally, the quality of institutions and the exchange rate are the main channels that capture the negative effect of natural resources on Africa's economic diversification.

This research extends the contribution of the empirical literature on the specific factors affecting the diversification of countries endowed with natural resources (Alsharif et al., 2016; Harding and Venables, 2016; Ross, 2019; Djimeu and Omga, 2019). It goes beyond the aforementioned empirical analyses, by taking into account the renewable and non-renewable nature of natural resources. In addition, the economic diversification of African countries is analysed in two ways: the count and weighting of products (diversification index), and, to an even greater extent, analysis of the effect of the dependence on natural resources on total exports (% exports) and on national production (% GDP) of African countries.

A methodological approach based on the fixed-effect panel data model was developed from the United Nations Commodity Trade Statistics Database (UN COMTRADE) data on export products from 2000–2015. The study shows that the presence of non-renewable (oil and gas) and renewable (agricultural products) resources in African exports accentuates the concentration in terms of the number of products and weighting. The negative effect of oil occurs through the degradation of institutional channels as measured by corruption, and as agricultural resources pass through the exchange rate channel.

Africa is relatively well endowed with natural resources, which has a prominent place in trade. Indeed, about 30% of the world's mineral reserves, 8% of oil reserves, and 7% of natural gas, are found in Africa (IDEA,[1] 2017). Moreover, according to the Global Sustainable Development goals (2019) of the United Nations, the continent accounts for 24% of global arable land, and has only 9% of global agricultural production. In addition, agriculture remains the main source of employment in African economies, encompassing about 57% of the total labour force, and it is the main source of income for 90% of the rural population (Kanu et al., 2014). In addition, sub-Saharan Africa accounts for 15% of cultivated land globally, and 7% of the global value of agricultural production (OECD/FAO, 2021).

In its 2015 report on economic development in Africa, the African Development Bank (AfDB) states that at that point in time, more than 45 of the 54 African countries had proven reserves of oil and/or natural gas. Central Africa is the part of the continent richest in natural resources. On average, 47% of its GDP comes from rents derived from natural resources, especially from oil. In North Africa, these rents account for 30% of the regional GDP, while East Africa is the most deprived part of the continent. In West Africa, many countries are large agricultural producers, that is, it is the region of the continent that has the highest percentage of arable land (African Development Bank, 2015) with more than 60% of the total agricultural value of sub-Saharan Africa ,and on average 15% of the GDP of sub-Saharan Africa (OECD/FAO, 2016). The same report also confirms that maize continues to account for the largest share of export growth from traditional producers (South Africa, Zambia and Ethiopia). Furthermore,

cotton has become an income crop in some countries such as Benin and Mali, where the increase in annual cotton exports exceeds 1.7%.

These figures confirm a strong presence of natural resources in Africa. Thus, as the law of factor proportions suggests, commodities have a heavy weighting in the supply portfolio of the continent. Indeed, they represent about 70% of the total volume of extra-continental exports, while manufactured products account for only 15% (CNUCED, 2021). The AfDB also estimates that newly discovered gas and mineral reserves could contribute between 9% and 31% of additional government revenue during the first 10 years of exploitation in countries such as Ghana, Liberia, Mozambique, Sierra Leone, Tanzania and Uganda. In oil-producing countries, rents represent more than 50% of GDP. Agricultural land represents 37% in sub-Saharan Africa and 25% in North Africa (AfDB, 2015).

For the African countries concerned, these natural endowments play a significant role, both from the point of view of the structure of domestic production and the profile of their international trade. If these resources can provide the basis for a structural transformation of the economies, which should lead them to appreciable levels of economic and social development, they can also generate negative effects for the structural composition of sectoral productive activities and the international exchange of the countries on the one hand, and slow down the process of economic emergence on the other hand, in particular through the Dutch disease and the degradation of the quality of the institutions. However, it should be noted that resources, whether renewable or non-renewable, do not have the same effects on economic growth. Some such as oil and natural gas (non-renewable resources) are more sensitive to the resource curse than agricultural ones (renewable resources).

By definition, diversification is a process of migration from a productive structure dominated by the primary sector to the secondary and tertiary sectors (Hammouda et al., 2006; Kamgna, 2007). It could be beneficial for Africa insofar as it makes it possible to speed up the development process of a country by reducing its dependence on basic products and by creating new jobs (Moussir and Tabit, 2016; Elhhiraika and Mbate, 2014). It not only helps to stabilise export earnings, but also to dilute the risks of the vagaries that affect the sectors of the national economy (Kamgna, 2007). Consequently, several African countries are implementing policies to reduce dependence on natural resources in export earnings and to strengthen the productive system. This is the case in Nigeria, which has succeeded in reducing the weight of oil revenue in GDP. Similarly, Mauritius, South Africa, and Botswana have taken steps towards diversifying their export offer. With all these policies, the African export supply portfolio remains concentrated. In addition, African countries have not taken advantage of mechanisms that can help them diversify their economies beyond natural resources.

The rest of this paper is structured as follows: the second section reviews the literature, followed by the econometric methodology and the data in the third section. The fourth section highlights the results of the estimations, while the last section concludes and offers implications and recommendations.

2. Literature review

Theoretical Literature

Diversification as a theme emerged for the first time in American economies during the inter-war crisis in the 1930s, marked by the dramatic fall in commodity prices (Berthélemy, 2005; Kamgna, 2007). Diversification was then discussed in the 1950s by authors such as Prebish (1950), who defined strategies that could make economies less dependent on commodities. According to this author, specialisation is not favourable to developing countries rich in natural resources because they have very unstable prices.

The economic literature includes various studies showing that export diversification is perceived as a means of offloading commodity dependence and reducing the volatility of commodity prices (Singer, 1950; Dennis and Shepherd, 2011; Hesse, 2009). Natural resources have always been an engine of growth in traditional economies and a basis for diversification. Indeed, by diversifying trade beyond natural resources, the economy could obtain considerable gains, particularly in the short term, with a reduction in the volatility of exports and of sectoral and aggregate economic activity, and in the long term with a sustained growth rate.

However, in the recent literature, a negative relationship is starting to emerge between natural resource abundance and diversification (Gelb, 2010; Omgba, 2014; Cherif et al., 2016; Cherif et al., 2016 ; Mazarei, 2019; Kireyev, 2021). The more that exports are concentrated, the more vulnerable they are to external shocks, leading to income volatility and weak growth (Agosin and Arango, 2015). This underlies a resource curse phenomenon caused by various mechanisms that have been developed in the economic literature. In the literature, authors put forward various explanations for this phenomenon. Some authors indicate that this can be explained by the concentration of resource-rich economies, and others attribute it to the concentration of export earnings. Conversely, others highlight the concentration of export revenues. This indicates that there are proponents and opponents of this phenomenon.

For proponents of the curse, abundant resources can make the export sector uncompetitive, which explains why resource-rich countries have never experienced export-led growth (Sachs and Warner, 2001). It is in this sense that Jetter and Hassan (2012) argue that the abundance of natural resources seems to go hand in hand with poor diversification. In other words, countries where natural resources play a vital role

are finding it difficult to diversify their export basket because of their considerable gains. However, the opponents of the curse phenomenon have questioned this thesis. According to Ledermann and Maloney (2003), the concentration of export revenues can harm growth. Therefore, the abundance of natural resources is not detrimental to growth, it is rather the concentration of export revenue that is harmful. Resource-rich countries must diversify their supply to avoid the curse by putting rents to work into productive investments. Thus, according to Stiglitz (2006), the natural resources curse is the consequence of bad public policy decisions rather than the manifestation of a singular destiny. This phenomenon, called the paradox of the abundance of natural resources, can be explained by different mechanisms.

For some authors, the Dutch syndrome (Dutch disease), through the exchange rate channel, can explain this phenomenon. The Dutch disease is an obstacle to economic growth on the demand side because it limits investment opportunities (Bresser-Pereira, 2008). Indeed, the appreciation of the real exchange rate following an oil or gas boom can crowd out other sectors that already existed before the exploitation of natural resources, in particular, the industrial sector in developed countries and the agricultural sector in developing countries (Liman-Tinguiri and Legakis, 2014). This phenomenon naturally handicaps the exports of these sectors. Most of the Dutch disease literature emulates the founding works of Corden (1984) and Krugman (1987). According to Gylfason et al. (1997), when the Dutch disease not only involves an appreciation of the real exchange rate but also increases the volatility of the exchange rate, the commercial sector (and therefore productivity growth) is depressed because investment is reduced. This suggests that specialisation in primary industries can be a barrier to economic diversification into non-primary industries (Ross, 2019; Lashitew et Werker, 2020; Lashitew et al., 2021).

Three mechanisms can explain the effect of this phenomenon. The first is the spending effect, which comes from the aggregate demand created by resource revenues that, if converted into national currency, can create periods of excess demand in the economy. The second is the resource movement effect, which is a reallocation of the factors of production as capital and labour from other sectors towards that of the boom. These two movements have a protagonist effect (Larsen, 2006). There is a third mechanism (rarely cited in the literature) called the spillover-loss effect, which resides in the loss of positive externalities associated with the non-tradable (crowded out) sector. This movement leads to a decrease in employment in other sectors, thus resulting in a direct de-industrialisation of a country (Larsen, 2006).

Conversely, the channel of institutional degradation is also a determining factor in the negative effect of natural resources on export diversity. In the economic literature, several explanations have been put forward for this. Some studies postulate that it is the voracity effect that is at the base of this phenomenon (Tornell and Lane, 1999). Indeed, in resource-rich countries, the presence of interest groups can reduce economic growth. As a result, increasing resource revenues may lead to pressures to increase each group's share. This misallocation of resources can lead to a reduction in productivity and, therefore, in economic growth.

Corruption is also a plausible explanation for institutional quality (or lack thereof). Current research shows that resource-rich countries are among the most corrupt. The effect of resources on corruption is probably non-linear (Leite and Weidmann, 1999) and depends on the types of resource. Countries with the lightest concentration of oil, and minerals (non-renewable resources) are more prone to corruption than those that rely on agricultural products (renewable resources) (Sala-i-Martin and Subramanian, 2003). For Shirley (2005), good institutional quality promotes economic development by encouraging trade and inciting the state to respect private property. Conversely, the presence of weak institutions encourages predation activities, which, in turn, degrade the quality of institutions and contribute to turning resources into a curse.

The literature tends to limit the debate of the resource curse to non-renewable resources. It should be noted that renewable resources can make the export basket concentrated, but do not have the same negative effects as the others. This study does not place all resources in the same category. Some renewables, such as agricultural products, do not have the same effects on economic performance as oil or gas (non-renewable resources). The latter are more prone to the negative effects of the deterioration of institutions and the Dutch disease. This can be explained by their gains and usefulness.

Empirical Literature

Recent studies in the empirical literature have found a negative relationship between resource abundance and export diversification. In this respect, the empirical literature supports the theoretical literature. Alsharif et al. (2016) used panel data covering the period 1962–2012 through a simple regression model. In this study, they found a negative relationship between oil resources and export diversification, which is an indication of the resource curse. Furthermore, Ross (2019) analysed the economic diversification of the 38 largest oil-producing countries over the period 1962–2010. He found that an increase in diversification leads to a decrease in oil wealth. It is in this sense that Djimeu and Omgba (2019) showed in a study of 186 countries over the period 1965–2010, through an OLS estimation method, that oil booms reduce the export diversification of oil countries when accompanied by low levels of diversification. They also deduce that good institutional quality reduces the concentration of exports, and that the boom only reduces diversification when countries had a small manufacturing sector before the boom.

In an empirical study based on statistical analysis done in Central Africa, Koutassila (1998) concluded that Congo was showing signs of the Dutch disease because of an increase in oil exports. Furthermore, Liman-Tinguiri and Legakis (2014) explain that the discovery of oil in Nigeria led to a strong appreciation of the Naira, thus decreasing the competitiveness of Nigerian agricultural products on the world market. Moreover, through an empirical verification of the determinants of diversification of the Nigerian economy, Arawomo and Oyelade (2014), using panel data through a GMM system, have shown through empirical verification of the determinants of the diversification

of the Nigerian economy that Nigeria's real exchange rate is detrimental to economic diversification. Additionally, Xie et al. (2021) found, through the fixed-effect method, that the concentration of extractive industries crowds out non-extractive industries in natural resource-based Chinese cities, and reduces their economic diversification.

From an institutional perspective, several studies have been conducted on how institutions can influence the effect of natural resources on diversification. Belarbi et al. (2015) examined the interaction effect between institutional quality and resource dependence. They used a panel model threshold regression over the 1996–2009 period covering 23 oil countries. They concluded that in industrialised countries, the quality of institutions reduces the effect of resources on growth, while in countries like Algeria this mechanism is not operated. In the same vein, Sala-i-Martin and Subramanian (2003) have shown that the underperformance of the Nigerian economy was due to the weakness of its institutions. Conversely, Matallah (2020) showed that governance is a key ingredient in the recipe for diversification, while oil rents hinder economic diversification by encouraging rent-seeking activities.

Furthermore, some studies looked at other factors that may explain diversification. Analysing the relationship between diversification and per capita income, Imbs and Wacziarg (2003) were able to find a non-monotonous U-shaped relationship. Thus, countries diversify in order to spread equitable economic activity across sectors, but they reach a certain level where they begin to specialise. This is exemplified in the study by Cadot et al. (2011), who found a hump-shaped relationship between diversification and level of development. Elhhiraika and Mbate (2014) also highlighted the role of infrastructure as a very important factor in the diversification of African economies.

All of the research tends to focus on studying the effect of non-renewable resources (especially oil). They tend to measure the dependence of resources on the rents (% GDP) drawn from them (Djimeu and Omgba, 2019; Alsharif et al., 2016). An analysis can reveal how a variety of natural resources (renewable and non-renewable) can affect the African export basket, through the measurement of the production of these considering trade and relative to domestic production.

This study extends the researchers' contribution in aiming to distinguish the types of products linked to the degradation of institutions (the products of corruption) or Dutch disease by comparing the resources to see which are more prone to the effects of the natural resource curse. It offers pointers that can guide African countries to prioritise reducing the concentration of their economies.

In light of the important works in the literature, it would be useful to analyse the empirical contribution of these factors, updated in the specific context of the diversification of African economies. This contextual analysis is all the more relevant as the results from the empirical literature seem to be country- specific. Most studies on the negative effects of natural resources have not taken into account the character of the resources. Experience has shown that non-renewable resources (such as oil or natural gas) are more susceptible to the negative effects of the curse than renewable ones (agricultural products). This study will take into account these significant aspects of the literature. The focus will be on diversification within the agricultural sector,

especially as the study is on countries in Africa where agriculture occupies a prominent place in a number of economies. Processing agricultural products could be an effective strategy for some African countries. For example, products such as peanuts can be made into different by-products. This could encourage the development of the agro-industry sector, see a breakthrough in new products being developed, and encourage economic diversification.

3. Methodology and data

As part of this study, we will use the panel data model linked by two diversification measurement indicators: the number of product lines exported and the standardised Herfindahl-Hirschman index.

The count of product lines covers the number of active product lines (non-zero exports) exported by countries. This measure of diversification is the simplest, and is used to explore diversification along the extensive margin. This margin is at the root of export growth and affects the addition of export lines. The index was used by Cadot et al. (2011) in a study on the economic diversification of developing countries.

There are a variety of additional indices used in the economic literature, namely: the Gini index, Ogive index, Theil entropy index, and the Herfindahl Hirschman normalised index (HHIN). The Gini index is one of the simplest. It can be calculated by first ordering the export items (at the appropriate level of aggregation) and increasing the size (or share), then calculating the shares of cumulative exports. However, the fact that it is not decomposable and has the disadvantage of not measuring the concentration itself but rather the inequality of the distribution of the data, poses a problem. Moreover, the Gini indices are close to 1 (one) and do not vary. The Theil and Herfindahl indices are more revealing. The Theil index has the property of being able to calculate groups of individuals (export lines) and decomposed into intra-group and inter-group components (the intra- and inter-group components are added to the overall index). Nevertheless, most of these listed indices have been shown to be highly correlated and provide the same ranking in terms of export concentration/diversification (Elhhiraika and Mbate, 2014). Berthélemy (2005) and Agosin et al. (2012) find almost the same results using differentiated concentration indices. On this basis, we use the normalised Herfindahl-Hirschman index which makes it possible to assess the degree of concentration/diversification of countries (Ngangoue, 2016), and is sensitive to variations in commodity prices, which are used in this study. This index captures the weight of products and cumulatively captures the intensive and extensive margins of economic diversification. It was used by Elhhiraika and Mbate (2014) in a study assessing the determinants of diversification in Africa, and is presented as follows:

$$\mathrm{HHIN} = \frac{\sqrt{\sum_{i}^{N} P_i^2} - \sqrt{\frac{1}{N}}}{1 - \sqrt{\frac{1}{N}}} \qquad (1)$$

With $P_i = \frac{x_i}{X}$ representing the share of exports of product i in the country's total exports, and N is the total number of products exported. However, this index is bound between 0 (extreme diversification) and 1 (extreme concentration).[2]

In this case, to test the link between natural resources and the diversification of exports, we use panel data over the period 2000–2015, referring to the studies of Cadot et al. (2011), Klinger and Lederman (2006) and Bebczuk and Berrettoni (2006), who used a panel of countries to empirically analyse the determinants of export diversification. We estimate the following regressions:

$$Y_{it} = \beta_0 + \beta_1 Oil_{it} + \beta_2 Gas_{it} + \beta_3 Agri_{it} + \beta_4 GDP/cap_{it} + \beta_5 GDP/Cap2_{it} + \beta_6 timexport_{it} + \beta_7 MVA_{it} + \beta_8 Corp_{it} + \beta_9 RER_{it} + \varepsilon_{it} \quad (2)$$

$$HHIN_{it} = \beta_0 + \beta_1 Oil_{it} + \beta_2 Gas_{it} + \beta_3 Agri_{it} + \beta_4 GDP/cap_{it} + \beta_5 GDP/Cap2_{it} + \beta_6 timexport_{it} + \beta_7 MVA_{it} + \beta_8 Corp_{it} + \beta_9 RER_{it} + \varepsilon_{it} \quad (3)$$

Where Y_{it} and $HHIN_{it}$, respectively, denote the number of products exported and the standardised Herfindahl-Hirschman diversification index in country i for year t, β_i are coefficients of the explanatory variables, listed below, and ε_{it} is the error term. The econometric regression will use either the count indicator (Y_{it}) or the standardised Herfindahl-Hirschman index ($HHIN_{it}$) as the dependent variables. It should be noted that in this study, the natural resource variables of Equations 2 and 3 are measured either as a share of trade (% exports) or as a share of national production (% GDP).

Additionally, to capture the different channels that can affect the diversification of African countries, we will estimate the effect of natural resource variables on corruption (for the institutional degradation channel) in accordance with the studies of Lashitew and Weker (2020), and the real exchange rate (for the Dutch disease channel), in accordance with the studies of Spatafora and Warner (1995). The explanatory variables are:

- Oil and gas are the oil and gas resources (weight of the sector). In this study, the share of the two sectors in total exports (oil/export and gas/export) and in national production (oil/GDP and gas/GDP) will be considered. The relatively large size of these sectors may indeed crowd out the other sectors, reducing their export potential, which has a potentially negative effect on the level of diversification.
- Agri represents agricultural resources. This variable will allow us to capture the main agricultural products of African countries (see table A11) suitable for processing. We also consider the weight of these relative to trade (agri/export) and to domestic production (agri/GDP). It should be noted that the agro-industry sector cannot be included in agricultural exports due to processing. Therefore, it is comparable to the industrial sector and can positively affect

the basket of exports. Conversely, if these products are exported without transformation, they can act negatively/positively on diversification.

- GDP/cap is per capita income, a variable that has a significant role as an explanatory factor in the diversification process. Indeed, diversification improves as the level of economic development measured by GDP/per capita increases, but it reaches a certain threshold (turning point) where countries begin to specialise (Imbs and Wacziarg, 2002). We use the squared form (GDP/Cap^2), which will allow us to see the threshold effect.
- timexport is the lead time to export a product, i.e., the time between the shipping point and the port of reloading. This variable provides information on the time and speed of export. A relatively short delay should positively affect diversification. This variable is expressed in number of days.
- MVA is the manufacturing value added (% GDP), which is the net production of the sector deducted from inputs and outputs. This variable captures the diversification of the productive structure. Diversifying exports beyond primary products means the development of production (and then exports) in other sectors, in particular manufacturing. The interest of this sector lies in its potential to reduce poverty in the African economy, particularly in relation to the oil sector (Cadot et al. 2016).
- Corp is the corruption perceptions index, which measures the degree of perceived corruption in a country. It provides information on the role that institutions can play in the process of country diversification. A relatively low level of corruption can promote economic diversification by reducing transaction costs associated with trade (Shirley, 2005). However, corrupt practices take place behind closed doors, away from the public eye, and it should be noted that measures of the perception of corruption reflect the highly subjective views of individuals or companies operating in the public and political sectors. They can present the realities on the ground in a distorted way (CEA, 2016), hence the difficulty of measuring it. According to Sequeira (2012), "confirmation bias" is considered to be a major drawback of the measure. This index varies between 100 (low level of corruption) and 0 (very corrupt).
- RER is the real exchange rate, the monetary value of an area, making it possible to capture the effects of the Dutch disease, which is one of the mechanisms by which the abundance of natural resources can reduce the external competitiveness of other sectors, and therefore act negatively on the level of diversification of the country's exports.

The methodological approach of this study is based on studies by Berthélemy (2005) and Imbs and Wacziarg (2002) on the determinants of diversification in the context of linear regression on panel data. This consists of combining time series and instantaneous cross-sectional observations. First, the use of panel data makes it possible to simultaneously account for the dynamics of behaviour and their possible heterogeneity. Second, it allows cross-sectional and serial estimations,

thus improving the specification of the model. The choice of estimation method is based on assumptions, parameters, and disturbances. The first thing to check is the homogeneous or heterogeneous specification of the data-generating process. This involves, among other things, testing the equality of the coefficients of the model studied in the dimension. From an economic point of view, it is necessary to determine whether it can be assumed that the model is perfectly identical for all countries, or whether there are specificities unique to each country.

This study covers the period 2000–2015 divided into four time points (i.e., making observations every 5 years). This process makes it possible to see the effects of changes in the explanatory and dependent variables. In the panel dimension, it is often interesting to identify the effect associated with each individual, i.e., an effect which does not vary over time, but varies from one individual to another, and the effect can be random or fixed. Conversely, the use of ordinary least squares (OLS) could not control the heterogeneity of the observations. As a consequence, within the framework of the estimates, the Fisher, Breuch-Pagan and Hausman tests will be carried out in order to validate the method used.

Furthermore, there may be a causal relationship between the correlation hypothesis and an endogeneity bias in the observations. A better way to solve this problem is to lag the resource variables and see if the initial endowments affect the subsequent diversification pattern. The endowment in natural resources can affect the composition of the exports at the beginning of the period of the study, (the year 2000), and this can, in turn, affect the institutions and the rate of exchange. The estimates will then be based on the equations presented earlier. We can thus assume that the share of resources in national production (GDP) and the level of exports are correlated with the level of diversification. In this case, for the relationships to be interpreted in causal terms, we will consider the lagged resource variable. If the lagged resource values turn out to be insignificant, it could be concluded that the relationship is nothing more than a correlation (where the analysis cannot identify causal effects). However, if the lagged variable is significant, the relationship we have could be interpreted as causal.

4. Data and descriptive analysis

In this paper, data on the export products of African countries at the six-digit level of the Harmonized System (HS6) are taken from the Commodities Trade Statistics Database (COMTRADE). These data allow us to calculate our two indicators for measuring diversification. Gross oil and gas production are obtained from the OECD (Organisation for Economic Co-operation and Development) and the EIA (Energy Information Administration), respectively. Their value (in US$) is calculated from the prices that are extracted from the BP Statistical Review of World Energy (2018) reports. Agricultural production is obtained from the FAOstat (Food and Agriculture Organisation of the United Nations) database. The shares of resources (oil, gas and agricultural products) in exports are obtained from the COMTRADE database. Data for the other explanatory variables are taken from the the World Bank (World Development Indicators), UNCTAD (United Nations Conference on Trade and Development), Transparency International, and the Logistics Performance Index (LPI) database (see Table A1 in the Appendix).

Table 1: Descriptive statistics

Variables	Obs	Mean	Std. Dev.	Min	Max
Number of products	164	1429.35	1208.08	7	5039
Diversification index	164	43.47	22.12	11.161	99.32
Oil%export	164	9.63	24.05	0	99.36
Oil%GDP	164	4.86	13.67	0	84.62
Gas%export	164	1.137	5.07	0	34.24
Gas%GDP	164	0.84	3.07	0	25.17
Agri%export	164	13.64	21.58	0	90,79
Agri%GDP	164	2.78	3.365	0.00	22.81
GDP/capita	164	378477.2	820146.8	140.84	5758279
GDP/capita square	164	8.12E+11	3.70E+12	19836.14	3.32E+13
Corruption	164	32.32	10.30	12	63
Real exchange rate	164	106.60	34.75	57.74	440.20
Manu%PIB	164	12.22	7.32	2.89	49.58
Time to export	164	3.98	2.12	1	14

Source: Author calculation, 2000–2015.

Table 1 shows that, on average, African countries export 1,429 products with an index of 43.473%. Furthermore, the minimum number of exported products is 7 (generally in oil-exporting countries, such as Angola) and there is a maximum of 5,039 products (exported by more diversified countries, such as South Africa). With regard to the representativeness of natural resources (renewable and non-renewable), the description of the data shows that the average agricultural rate largely dominates, followed by oil resources, while natural gas is under-represented (in export volume and in terms of GDP). For a better visualisation of these resources, please see the scatter diagrams in Figure B1 in the Appendix. As the purpose of this study is to show how the different resources evolve in the African continent, we constructed a representation of countries with renewable and non-renewable resources, with their diversification indicators (see Figure B2 in the Appendix).

The graphic representations in Appendix B1 show that in countries where oil is not abundant, agricultural products are more important and somewhat more diverse. We note that there have been changes over time in countries such as South Africa where agriculture dominated in the 2000s, but from 2015, production largely decreased. In Algeria (the first producer of natural gas in Africa), we see that oil dominates exports. Conversely, in 2015 there was equality of oil and natural gas export volumes. However, oil has more weight in national production (GDP) than other resources, followed by natural gas. This situation was also observed in Egypt, but gas production was higher in 2005. Unlike in Algeria, agriculture is important in Egypt, with a higher share of GDP than oil and natural gas in 2010. In countries like Nigeria and Gabon, oil exports represent more than 90% of total exports over 60% of national production. Moreover, agricultural and natural gas products are not especially important. This indicates there is a strong concentration of these savings in oil products.

The graphical representation of the distribution of the two diversification indicators is displayed in Appendix B2. The charts show that South Africa has the most diversified basket and exports more products (5,039), with an index of 11%. Countries exporting fewer products have a more concentrated index. This is the case for Angola, where oil largely dominates its exports with index values of over 90%. This is also the case in Gabon, with an index hovering around 80%. Nigeria (the first oil producer and exporter in Africa also has a relatively concentrated basket, but exports more products than the others. Furthermore, in Table A10, we can observe that countries like South Africa have a low representation of non-renewable resources (oil and gas). These statistical results will be verified as part of our econometric estimates.

5. Results of estimations and interpretations

Table 2 shows the overall regression of the different variables. The Hausman test (see Table A2 in the Appendix) suggests that the fixed-effects estimator is preferable to the random-effects estimator (in both cases) for consistency reasons. The usable sample includes 164 observations (i.e., 41 African countries) over the period 2000–2015 (with four-time horizons). The quality of adjustment and the F-stat have a satisfactory overall significance for both regressions. It should be noted that the debate on interpretations is structured around four sets of results. The results use the count indicators (Count) and the diversification index (HHIN) as dependent variables, and those relating to the resource variables are measured as a share of total exports and GDP. Moreover, for the interpretation of these results, it is important to know that the coefficients are not interpreted in the same way for the two cases: a positive sign is good for the count indicator, and for the diversification index (HHIN) it shows a tendency towards concentration (therefore, not favourable diversification).

Table 2: Fixed effects estimations of factors explaining diversification

VARIABLES	COUNT	HHIN
Oil/export	-26.32**	0.84**
	(14.71)	(0.35)
Oil/GDP	07.43	-0.02
	(7.01)	(0.17)
Gas/export	-54.17	1.44*
	(34.28)	(0.82)
Gas/GDP	28.55	0.13
	(21.80)	(0.52)
Agri/export	-13.09***	0.14*
	(3.57)	(0.09)
Agri/GDP	-4.46	0.46*
	(09.40)	(0.23)

GDP per capita	0.00***	-4.35E-07
	(0.00)	(4.89E-06)
GDP per capita squared	-7.14E-11**	-4.56E-13
	(3.48E-11)	(8.33E-13)
Corruption	11.47	0.11
	(7.33)	(0.18)
RER	1.88*	-0.01
	(0.94)	(0.02)
Manufacturing added value	4.87	0.60*
	(14.62)	(0.35)
Lead time to export	4.48	-0.52
	(28.61)	(0.70)
Constant	1118.96***	15.65
	(425.82)	(10.21)
Observations	164	164
Prob>F	0.000***	0.0111**
Within	0.2980	0.2003
Between	0.1601	0.1972
Year dummies	Yes	Yes

Notes: The variables explained are the number of active product lines and the normalised Herfindahl-Hirshman index. Values in parentheses are standard deviations and significance levels at 1%, 5% and 10%, are indicated by ***, ** and * respectively.

The overall reading of the results shows that the presence of non-renewable resources (oil and natural gas) and renewable resources (agricultural products) in the exports of African countries is not in favour of diversification from the point of view of the diversification index as a counting indicator. In other words, the strong presence of natural resources (oil and agricultural) in exports has a similar (negative and significant) effect on diversification. The strong presence of oil resources is associated with a reduction in the number of products exported by 26.32% and by 0.84% in terms of the weight of diversification. Similarly, agricultural products reduce diversification by 13.09% in terms of products and 0.14% in terms of weighting. However, natural gas acts only on the diversification index and reduces the weight of diversification by 1.44%. In addition, from the point of view of national production, only agricultural resources have a negative effect on the diversification index, at 0.46%. The negative impact is felt more with the presence of non-renewable natural resources (especially oil). Thus, these results are consistent with the postulate that an abundance of natural resources is not in favour of diversification, especially in low-income countries, and especially in African countries where industrial development is lagging. In the African context, the conclusion is in line with the results of some previous works that were able

to find a negative correlation between natural resources and export diversification (Alsharif et al., 2016; Cherif et Hasanov, 2016).

The results of this paper show that the presence of natural resources tends to further encourage the specialisation of African countries in basic products. This could be explained by the fact that these resources (especially non-renewable ones) generate considerable gains, pushing African countries to focus on only a handful of products. For example, on the international market, an increase in the prices of raw materials such as oil can lead to an increased concentration of the export supply of some materials, because of the fallout from the price increases. However, when we analyse them from the point of view of domestic production (relative to GDP), we see that only agricultural products affect the diversification index. This could be explained by the strong presence of agricultural resources in the national production of African countries, as shown by the descriptive statistics.

Furthermore, the result relating to the level of development, i.e., the GDP/inhabitant, shows that the level of development is significantly and positively linked to diversification (from the point of view of the counting indicator). In other words, as countries develop, the export supply increases. However, at an income threshold of 8.12E+11 (turning point), countries begin to specialise. Our results also confirm that the appreciation of the real exchange rate encourages countries to increase their number of exported products by 1.8% in order to earn more. This corroborates the idea that an increase in monetary value encourages countries exporting raw materials to offer more products on international markets. Conversely, the manufacturing value added presents an unexpected sign on the level of diversification in Africa (diversification index), which contradicts the literature. This result does not mean that the concentration of African exports tends to increase with the growth of the manufacturing sector, but simply that the contribution of this sector is not sufficient to promote any level of diversification in African economies. These results will be investigated separately to see how the coefficients change (Tables 3 and 4).

Table 3: Results relative to exports (%export)

	COUNT	HHIN
Oil/export	-13.39	0.80***
	(13.93)	(0.31)
Gas/export	-32.94	1.60**
	(31.73)	(0.72)
Agri/export	-13.08***	0.14*
	(3,58)	(0.76)
GDP per capita	0.00***	-1.66E-06
	(0.00)	(4.82E-06)
GDP per capita squared	-6.97E-11	-3.32E-13

	(3.45E-11)	(8.29E-13)
Corruption	13.25*	0.08
	(7.28)	(0.18)
RER	1.86**	-0.02
	(0.94)	(0.02)
Manufacturing added value	7.14	0.64*
	(13.72)	(0.33)
Lead time to export	-05.09	-0.39
	(27.64)	(0.66)
Constant	903.48	25.74***
	(345.29)	(8.30)
Observations	164	164
Prob>F	0.000**	0.0095**
Within	0.2750	0.1696
Between	0.1621	0.1617
Year dummies	Yes	Yes

Notes: The variables explained are the number of active product lines and the normalised Herfindahl-Hirshman index. Values in parentheses are standard deviation, and significance levels at 1%, 5% and 10% are indicated by ***, ** and *, respectively.

With the series estimating the share of natural resources in total exports, the results show that the presence of natural resources (renewable and non-renewable) in exports accentuates the concentration of African economies (count and diversification index). On the side of the counting indicator, only agricultural resources have a negative impact of 13.08%. However, on the side of the diversification indicator, all resources turn out to be significant and intensify the concentration. These results simply mean that these resources largely dominate African economies. Agricultural resources are developed in many countries of the continent, and each has a variety of products to export. As confirmed by the descriptive analysis of the data, agriculture and oil remain the most important sources of income in Africa, while natural gas has a weaker representation. However, it should be noted that contrary to the previous results (taken globally), oil exports have no impact on the number of exported products (not significant). It is also seen that the change in the values of the coefficients is almost negligible.

The per capita income variable and its quadratic form are consistent with the results of Imbs and Wacziarg (2003) and Cadot et al. (2011), where the coefficients are only significant for the counting indicator, as before. In addition, the improvement in the level of institutional quality (measured by the perception of corruption) tends to increase the number of exported products by 13.25%. A relatively low level of corruption favours the breakthrough of new products and widens the range of production and, therefore, economic diversification. The exchange rate shows the same results on the count indicator as before. The appreciation of the real exchange

rate encourages countries to increase their number of exported products, in order to to earn more. Similarly, manufacturing value added shows the same results as before.

These results simply mean that the two resources largely dominate African economies. Agricultural resources are generally developed in many countries on the continent, and each has a variety of products to export. In Africa, as the descriptive analysis of the data confirms, agriculture and oil resources are the most widespread, and natural gas has a lower representation, thus explaining why its exports are concentrated in raw materials. However, it should be noted that unlike the previous results (taken as a whole), oil exports have no impact on the number of products exported (not significant). We also see that the change in the values of the resource coefficients is almost negligible. Moreover, corruption and the exchange rate show the same results on the count indicator as before. The appreciation of the real exchange rate prompts countries to increase their number of exported products to earn more. A relatively low level of corruption favours the breakthrough of new products and widens the range of production, and therefore economic diversification.

Table 4: Results relative to gross domestic product (%GDP)

VARIABLES	COMPTAGE	HHIN
Petr/PIB	3.79	0.11
	(6.92)	(0.16)
Gaz/PIB	14.13	0.56
	(21.46)	(0.50)
Agri/PIB	-5.11	0.47**
	(9.90)	(0.23)
GDP per capita	0.00***	-1.58E-06
	(0.00)	(4.96E-06)
GDP per capita squared	-8.60E-11**	-2.86E-13
	(3.66E-11)	(8.48E-13)
Corruption	13.38*	0.04
	(7.63)	(0.18)
TCR	2.63***	-0.02
	(0.98)	(0.02)
Manufacturing added value	2.35	0.71**
	(14.60)	(0.34)
Lead time to export	-10.82	-0.27
	(14.60)	(0.69)
Constant	592.69	27.27***
	(414.15)	(9.60)
Number of observations	164	164
Prob>F	0.0029***	0.0418**
Within	0.1921	0.1383
Between	0.0109	0.0227

Notes: The variables explained are the number of active product lines and the normalised Herfindahl-Hirshman index. Values in parentheses are standard deviations, and significance levels at 1%, 5% and 10% are indicated by ***, ** and *, respectively.

Table 4 illustrates the estimates taken from the angle of national production (%GDP) and shows that only agricultural resources have an impact on the diversification of African exports, from the point of view of the diversification index. This could be because the indicators are calculated using export volumes and resources that often have very high shares in the exports of certain countries. Therefore, they do not affect the measurements in the same way. A resource may largely dominate a country's exports, but not its domestic production. This is the case in countries like Nigeria where oil resources make up more than 90% of the export volume and represent only 30% of GDP in 2015 (Chart B1). The levels of development, corruption, and the exchange rate show the same results as before.

In addition, the channels of corruption (degradation of institutions) and the exchange rate (Dutch disease) were estimated (see Tables A3 and A4). The presence of oil resources reduces the value of the corruption perception index by 0.36%. In other words, the importance of oil exports fosters corruption in African countries, especially in the public sector. This index captures the manifestation in a sector of a country, most often the public administration, that is highly associated with the exploitation of this resource. Corrupt behaviour arising from increased resources encourages predatory activities (Kolstad and Søreide, 2009; Matallah, 2020) and increased corruption. Thus, the effect of oil resources only passes through the channel of the deterioration of institutions. When these are well controlled, the oil endowment could be a lever for diversification, and therefore for the economic growth of the African continent. In addition, the high concentration of agricultural resources in exports is associated with a depreciation of the exchange rate of African countries' currencies. This simply means that the currency tends to depreciate with an increase in agricultural exports. So, the negative effect of agricultural resources on African economies is not explained by the Dutch disease. The assertion in the literature that suggests the Dutch disease affects the agricultural sector in developing countries due to their low level of industrialisation, is not verified in Africa.

Conversely, to check whether the relationships of the results obtained can be interpreted as being causal, additional estimates were run on the lagged resource variables (see Tables A5–A7). The results taken as a whole show that, from the point of view of the diversification index, the coefficients of the natural resource variables appear insignificant. However, from the perspective of the counting indicator, only the variables of oil resources relative to exports and agricultural resources relative to GDP have a negative and significant impact. Exports of oil and agricultural resources then tend to reduce the number of products exported. These dependency measures taken separately show different results from those taken as a whole. Indeed, taken from the point of view of exports, they show that only oil resources appear to be negatively significant concerning the number of products exported. Conversely, from the point of view of national production, the variables appear insignificant in both cases. The estimates of the resource variables on the different channels (see Tables A8 and A9)

show non-significant results. In other words, no channel captures the effect of natural resources on the diversification of past resource variables.

We may conclude that these results can be interpreted as causal or correlated depending on the approach of the analysis. Therefore, from the results obtained from the perspective of the diversification index, we can say that the relationship is nothing but a correlation, as the lagged values of the resources turn out to be insignificant. Therefore, the analysis cannot identify causal effects. However, from the point of view of the metering indicator, the non-renewable (oil) and renewable (agricultural products) resources turn out to be significant, so the relationship is nothing but causality. In addition, the relationship between the oil variable and diversification has more causality.

To check if the relationships of our results could be interpreted as causal, additional estimates were made with lagged resource variables (see Tables A4–A6). Taken as a whole, the results concerning the diversification index show that the resource coefficients appear insignificant, but in the count indicator, we see a significance of non-renewable natural variables.

Oil exports tend to decrease the number of exported products. Notwithstanding, natural gas, which had no impact on the basic estimates, appears significantly positive. Taken separately, these dependency measures show that the different results can be applied globally. Indeed, taken from the point of view of exports, they show that only oil resources appear to be negatively significant. Conversely, the presence of oil and agricultural resources in national products tends to decrease the number of products in the export basket. In other words, their strong presence in economic activity favours the reduction of the number of exported products.

There have been estimates of the effect of resource variables on the different channels (see Table A7). The results show that the effect of natural resources passes through the exchange rate channel. Only the negative effect of non-renewable resources (oil and gas) passes through this channel. The impact of the presence of oil on exports passes through the channel of the depreciation of the exchange rate. However, the impact of the presence of natural gas in exports and domestic production is captured only through the exchange rate channel. The strong presence of non-renewable resources favours the depreciation of the national currency.

6. Conclusion

This research enabled a view of the factors determining economic diversification in Africa. These are the contribution of natural resources (renewable and non-renewable), the income level, the infrastructure sector, the exchange rate, and corruption. The research followed a methodological approach based on two indicators for measuring diversification, namely, count of active product lines and the standardized Herfindahl Hirschman index. Within the framework of the fixed-effects model, we were able to analyse the effect of dependence on natural resources from two angles: first, relative to countries' trade (%export) and then, relative to national production (%GDP). Estimations of the natural resource variables on corruption (degradation of institutions) and the exchange rate (Dutch disease) have identified the different channels that can capture the effect of natural resources on the economic diversification of African countries.

The results of this paper suggest that renewable and non-renewable natural resources hurt the level of African economic diversification. This effect is more felt when analysed from an export supply perspective, thus confirming the specialisation of African countries in raw materials (renewable and/or non-renewable). Moreover, these negative effects are captured through the channel of the degradation of institutions (oil and agricultural resources) and that of the exchange rate for agricultural resources. The difference in the results of the two estimates (count and HHIN) lies in the standard approach to measuring diversification. Indeed, the count indicator only captures the extensive margin of diversification (i.e., adding products), and does not take into account the weighting of products. However, the diversification index captures both margins of diversification (extensive and intensive).

Thus, the results of this study imply a certain complexity in the diversification of the export supply basket of African countries, which draws from the diversity of explanatory factors, some of which relate to the presence of natural resources in exports and different channels, and others specific to the manufacturing sector, the level of institutions, and the exchange rate. The contribution of these factors can be the subject of measures of public interventions aimed at reducing dependence on resources and increasing the level of economic diversification in Africa.

Therefore, it would be necessary for Africa to diversify its supply portfolio to avoid commodity price shocks. To do this, African countries must also strengthen their institutional quality by fighting against corruption in certain countries, through

transparency, concerning the exploitation and export of natural resources, while establishing systems which can help citizens to have clear information on their use. The public sector must also ensure transparency in the signing of contracts to avoid corruption. Furthermore, they need to ensure the stability of monetary policies so that a depreciation of the exchange rate can be to their advantage. And, finally, they must orient the agricultural sector to processing and therefore develop the agro-industrial sector, which could encourage the breakthrough of new products. Developing this sector could be a good strategy for the diversification of African countries because several agricultural products are susceptible to transformation and each African country develops at least one agricultural product.

For future research, authors may incorporate other variables that could affect the diversification of Africa in order to broaden the analysis. Our analysis concerns only 41 African countries, including some countries in Central Africa, that has most of the continent's natural resources, although some are not included due to a lack of data. The availability of these data could enrich the literature. Oil and or natural gas-producing countries are also underrepresented due to a lack of information.

Notes

1 Institute for Democracy and Electoral Assistance.

2 Here the index is in percentage.

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Appendix A

Table A1: Sources of data

Variables	Sources
Trade by product	COMTRADE
GDP per capita	World Development Indicators/World Bank
Manufacturing added value	World Development Indicators/World Bank
Lead time to export	Logistics Performance Index (LPI)/World Bank
Corruption perceptions index	Transparency International
Real exchange rate	UNCTAD
Oil and natural gas production	Energy Information Administration (EIA)
Oil and gas prices	BP Statistical Review of World Energy
Agricultural production	FAOStat

Table A2: Specification tests

Test	Statistics	Probability	Hypothesis	Conclusions
Fisher	F_{COUNT} (40,108) =24.60 F_{HHIN} (40, 108) =13.88	0.000 0.000	H_0: No effect H_1: Presence of fixed effect	H_0 rejected
Breuch-Pagan	$Chibar2_{COUNT}$ (01) =124.88 $Chibar2_{HHIN}$ (01) =104.71	0.000 0.000	H_0: No effect H_1: Presence of random effect	H_0 rejected
Hausman	$Chi2_{COUNT}$ (11) = 11.23 $Chi2_{HHIN}$ (11) =12.32	0.04 0.01	H_0: Presence of random effects H_1: Presence of fixed effect	H_0 rejected

Table A3: Institutions and individual resources (IPC) channel

Variables	1	2	3	4	5	6
Oil/export	-0.36**					
	(0.15)					
Gas/export		0.24				
		(0.39)				
Agri/export			-0.01			
			(0.05)			
Oil/GDP				-0.08		
				(0.08)		
Gas/GDP					-0.07	
					(0.25)	
Agri/GDP						0.13
						(0.12)
Constant	35.80***	32.07***	32.41***	32.70***	32.38***	32.92***
	(1.44)	(0.56)	(0.71)	(0.51)	(0.40)	(2.45)
Observations	164	164	164	164	164	164
Prob>F	0.0145**	0.5507	0.8868	0.3261	0.7885	0.2883
Within	0.0480	0.0029	0.0002	0.0080	0.0006	0.0092
Between	0.1029	0.0022	0.0344	0.0718	0.0055	0.2718

Notes: Standard errors in parentheses.

* Significant at 10% ** Significant at 5% *** Significant at 1%

Table A4: Exchange rate channel and individual resources (RER)

Variables	1	2	3	4	5	6
Oil/export	-0.78					
	(1.12)					
Gas/export		-0.46				
		(2.94)				
Agri/export			-0.79**			
			(0.34)			
Oil/GDP				-0.68		
				(0.59)		
Gas/GDP					-0.77	
					(1.86)	
Agri/GDP						-1.42
						(0.90)
Constant	114.10***	107,12***	117,41***	109,90***	107,25***	135.18***
	(11.04)	(4,20)	(5,22)	(3,82)	(2,97)	(18.29)
Observations	164	164	164	164	164	164
Prob>F	0.4866	0,58774	0,0204**	0,2550	0,6784	0.1172

Within	0.0040	0,0002	0,0433	0,0106	0,0014	0.0200
Between	0.0038	0,0081	0,1038	0,0045	0,0135	0.0609

Notes: Standard errors in parentheses.

* Significant at 10% ** Significant at 5% *** Significant at 1%

Table A5: Overall estimation (with lagged variables)

VARIABLES	COUNTING	HHIN
Oil/Export_lag	-7.72**	0,05
	(3.34)	(0,08)
Oil/GDP_lag	8.68	-0,05
	(7.56)	(0,18)
Gas/Export_lag	1.50	-0,14
	(13.55)	(1,33)
Gas/GDP_lag	5.39	-0,25
	(16.96)	(0,55)
Agri/Export_lag	-1.40	-0,08
	(1.98)	(0,05)
Agri/GDP_lag	-6.25*	0,10
	(3.70)	(0,09)
GDP per capita	0.00***	-3,77E-06
	(0.00)	(5,13E-06)
GDP per capita squared	-8.25E-11**	-7,90E-14
	(3.66E-11)	(8,83E-13)
Corruption	14.89*	-0,02
	(7.64)	(0,18)
RER	2.79***	-0,03
	(0.96)	(0,02)
Manufacturing added value	6.64	0,83
	(14.08)	(0,34)
Lead time to export	-20.11	-0,27
	(28.57)	(0,69)
Constant	604.60*	37,63***
	(342.11)	(8,26)
Number of observations	163	123
Prob>F	0.0014***	0,2261
Within	0.2432	0,1246
Between	0.1077	0,1035

Notes: standard errors in parentheses.

* Significant at 10% ** Significant at 5% *** Significant at 1%

Table A6: Estimation relative to exports (with lagged variables)

VARIABLES	COUNTING	HHIN
Oil/Export_lag	-3.36*	0.01
	(1.86)	(0.04)
Gas/Export_lag	1.60	0.05
	(8.32)	(0.20)
Agri/Export_lag	-1.79	-0.07
	(1.99)	(0.05)
GDP per capita	0.00***	-3.60E-06
	(0.00)	(4.98E-06)
GDP per capita squared	-8.21E-11**	1.19E-13
	(3.62E-62)	(8.62E-13)
Corruption	15.88**	-0.01
	(7.67)	(0.18)
RER	2.61***	-0.03
	(0.96)	(0.02)
Manufacturing added value	9.42	0.80**
	(14.13)	(0.34)
Lead time to export	-19.09	-0.29
	(28.80)	(0.69)
Constant	434.44	40.20***
	(328.07)	(7.81)
Number of observatiions	163	163
Prob>F	0.0012***	0.1303
Within	0.2095	0.1116
Between	0.0849	0.1070

Notes: Standard errors in parentheses.

* Significant at 10% ** Significant at 5% *** Significant at 1%

Table A7: Estimation relative to GDP (with lagged variables)

VARIABLES	COUNTING	HHIN
Oil/GDP_lag	20.02**	-0.04
	(10.10)	(0.40)
Gas/GDP_lag	17.00	-0.41
	(16.16)	(0.63)
Agri/GDP_lag	-1.31	-0.17
	(3.06)	(0.37)
GDP per capita	0.13*	-0.01*
	(0.07)	(0.00)
GDP per capita squared	-8.43E-06**	2.03E-07
	(4.19E-06)	(1.65E-07)
Corruption	21.59***	-0.05
	(5.81)	(0.23)

RER	2.31***	-0.01
	(0.71)	(0.03)
manufacturing added value	21.64*	0.63
	(12.84)	(0.51)
Lead time to export	-22.75	-0.57
	(18.38)	(0.72)
Constant	71.73	56.14***
	(331.47)	(13.04)
Number of observations	123	123
Prob>F	0.0000***	0.3754
Within	0.3736	0.1192
Between	0.0659	0.3746

Notes: Standard errors in parentheses.

* Significant at 10% ** Significant at 5% *** Significant at 1%

Table A8: Institutional channel and individual resources (with lagged variables)

Variables	1	2	3	4	5	6
Oil/Export_lag	-0.151					
	(0.176)					
Gas/Export_lag		0.16				
		(0.72)				
Agri/Export_lag			0.03			
			(0.06)			
Oil/GDP_lag				-0.05		
				(0.19)		
Gas/GDP_lag					-0.38	
					(0.32)	
Agri/GDP_lag						-0.11
						(0.06)
Constant	33.84***	32.53***	31.89***	32.634***	32.706***	36.57***
	(1.78)	(0.94)	(0.869)	(1.160)	(0.504)	(0.59)
Observations	123	123	123	123	123	123
Prob>F	0.3913	0.8284	0.5539	0.7937	0.2375	0.1175
Within	0.0091	0.0006	0.0043	0.0008	0.0172	0.0300
Between	0.0824	0.0012	0.0412	0.0644	0.0024	0.0218

Notes: Standard errors in parentheses.

* Significant at 10% ** Significant at 5% *** Significant at 1%

Table A9: Exchange rate channel and individual resources (lagged variables)

Variables	1	2	3	4	5	6
Oil/Export_lag	0.06					
	(1.16)					
Gas/Export_lag		-1.02				
		(5.51)				
Agri/Export_lag			-0.66			
			(0.41)			
Oil/GDP_lag				-1.68		
				(0.46)		
Gas/GDP_lag					-1.80	
					(2.433)	
Agri/GDP_lag						-0.90**
						(1.45)
Constant	106.82***	108.60***	116.61***	116.76***	109.11***	147.24***
	(4.23)	(7.11)	(6.48)	(8.70)	(3.83)	(20.24)
Observations	123	123	123	123	123	123
Prob>F	0.7057	0.8541	0.1126	0.2550	0.4612	0.0500**
Within	0.0065	0.0004	0.0308	0.0160	0.0067	0.0466
		0.0099	0.0759		0.0134	
Between	0.0056			0.0045		0.0111

Notes: Standard errors in parentheses.

* Significant at 10% ** Significant at 5% *** Significant at 1%

Table A10: Matrix of oil and gas-producing countries

Countries	Exports oil share (%)				Exports gas share (%)			
	2000	2005	2010	2015	2000	2005	2010	2015
South Africa	0.13	0.01	0.02	0.14	0.15	0.00	0.02	0.06
Algeria	42.01	53.30	43.43	34.17	20.56	29.40	30.48	8.37
Angola	94.30	94.30	96.54	92.06	0.78	8.08E-05	0.00	0.11
Cameroon	48.03	43.81	36.50	40.09	0.10	4.77E-06	0.00	0.36
Côte d'Ivoire	1.92	6.98	10.61	4.60	1.59	4.61E-06	3.94E-05	0.98
Egypt	7.39	4.84	6.75	9.07	2.31	14.48	7.46	2.20
Gabon	81.4	82.58	82.00	82.07	0.20	4.96E-05	4.96E-05	0.43
Ghana	10.13	10.13	10.13	10.13	0.24	3.41E-05	3.41E-05	0.24

Mauritania	14.43	14.43	14.4	14.70				
Morocco					0.02	3.77E-06	3.77E-06	0.01
Mozambique					0.14	5.78	5.97	6.73
Niger	4.73E-05	0.00	3.13E-05	5.33E-05				
Nigeria	99.36	92.74	70.35	82.05	2.27	1.77	3.27	1.51
Tunisia	10.44	10.41	12.67	4.49	1.24	0.00	0.00	0.61

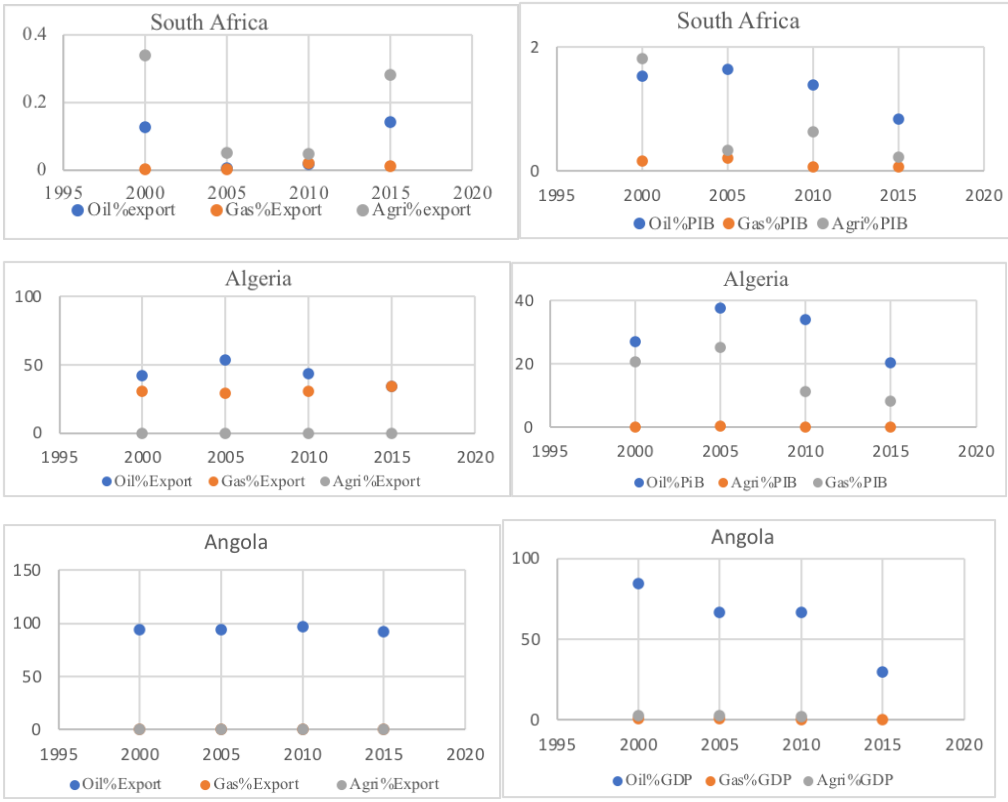
Table A11: Main agricultural products of African countries

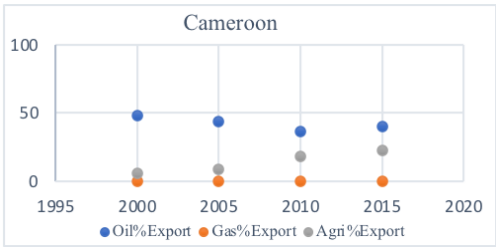
Countries	Type of products
South Africa	Maize, sugarcane, tobacco
Algeria	Wheat
Angola	Cassava, maize
Benin	Cotton, palm oil
Botswana	Coffee, tea
Burkina Faso	Cotton
Burundi	Coffee, tea
Cameroon	Cocoa, palm oil, rubber
Cabo Verde	Wheat, sugar, maize
Central African Republic	Coffee, cotton
Comoros	Vanilla, copra
Côte d'Ivoire	Coffee, cocoa, palm oil, rubber, cotton
Egypt	Maize, Wheat
Ethiopia	Coffee, maize, wheat
Gabon	Coffee, cocoa
Gambia, The	Groundnuts
Ghana	Cocoa, palm oil, rubber
Guinea	Coffee, nuts
Kenya	Wheat, coffee
Lesotho	Maize, wheat
Madagascar	Vanilla, cocoa
Malawi	Tobacco, tea
Mali	Cotton
Morocco	Wheat, tomato
Mauritius	Sugarcane
Mauritania	Rice, sorghum
Mozambique	Tobacco, copra, cotton
Namibia	Maize, millet, cotton
Niger	Cotton, palm oil

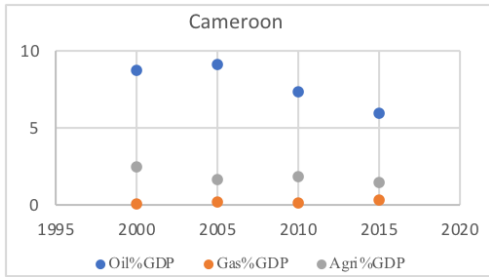
Nigeria	Cocoa, rubber, palm oil, maize
Uganda	Coffee, tea, tobacco
Rwanda	Coffee, tea
São Tomé and Príncipe	Cocoa
Senegal	Groundnuts, tobacco, fruits and vegetables
Seychelles	Copra, cinnamon
Eswatini	Sugar cane, tobacco, cotton
Tanzania	Cotton, maize, coffee
Togo	Cotton, coffee, cocoa
Tunisia	Olive oil, date, citrus
Zambia	Maize, sugarcane, tobacco
Zimbabwe	Tobacco

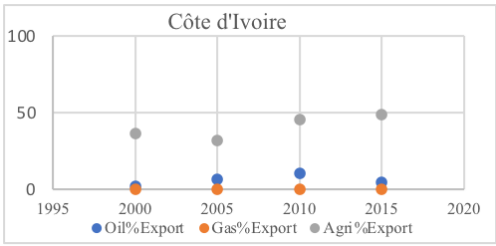
APPENDIX B

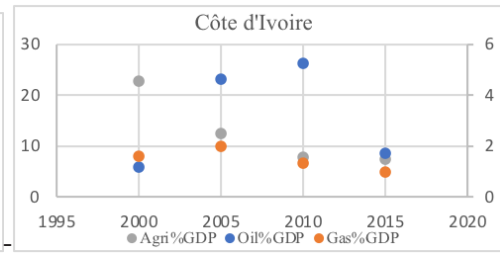
Figure B1: Distribution of natural resources in African countries

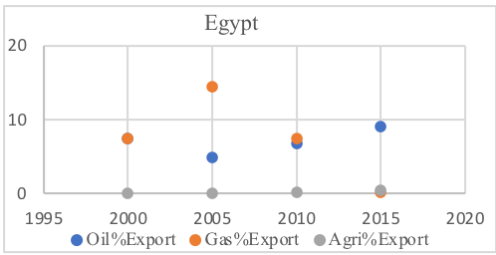


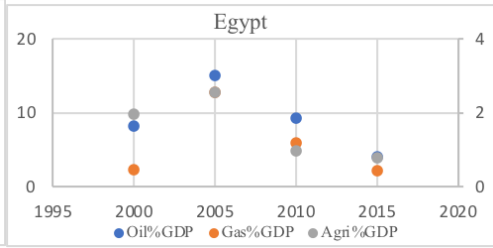

Cameroon
100
50
0
1995 2000 2005 2010 2015 2020
Oil%Export Gas%Export Agri%Export

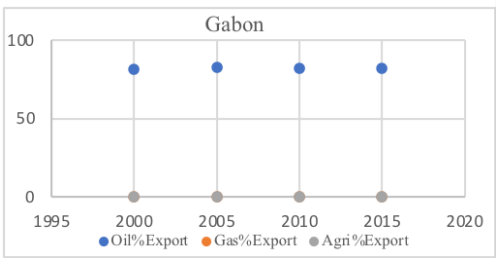

Cameroon
10
5
0
1995 2000 2005 2010 2015 2020
Oil%GDP Gas%GDP Agri%GDP

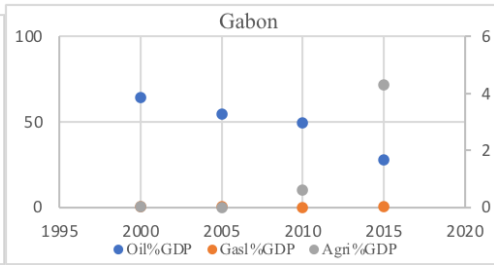

Côte d'Ivoire
100
50
0
1995 2000 2005 2010 2015 2020
Oil%Export Gas%Export Agri%Export

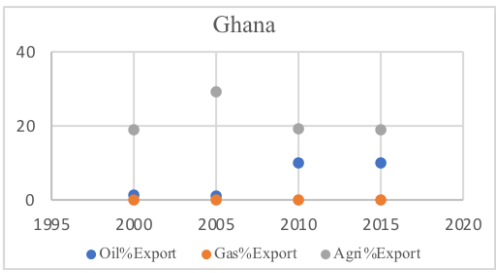

Côte d'Ivoire
30
20
10
0
6
4
2
0
1995 2000 2005 2010 2015 2020
Agri%GDP Oil%GDP Gas%GDP

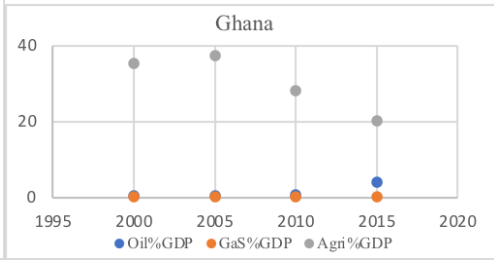

Egypt
20
10
0
1995 2000 2005 2010 2015 2020
Oil%Export Gas%Export Agri%Export


Egypt
20
10
0
4
2
0
1995 2000 2005 2010 2015 2020
Oil%GDP Gas%GDP Agri%GDP


Gabon
100
50
0
1995 2000 2005 2010 2015 2020
Oil%Export Gas%Export Agri%Export


Gabon
100
50
0
6
4
2
0
1995 2000 2005 2010 2015 2020
Oil%GDP Gasl%GDP Agri%GDP


Ghana
40
20
0
1995 2000 2005 2010 2015 2020
Oil%Export Gas%Export Agri%Export


Ghana
40
20
0
1995 2000 2005 2010 2015 2020
Oil%GDP GaS%GDP Agri%GDP

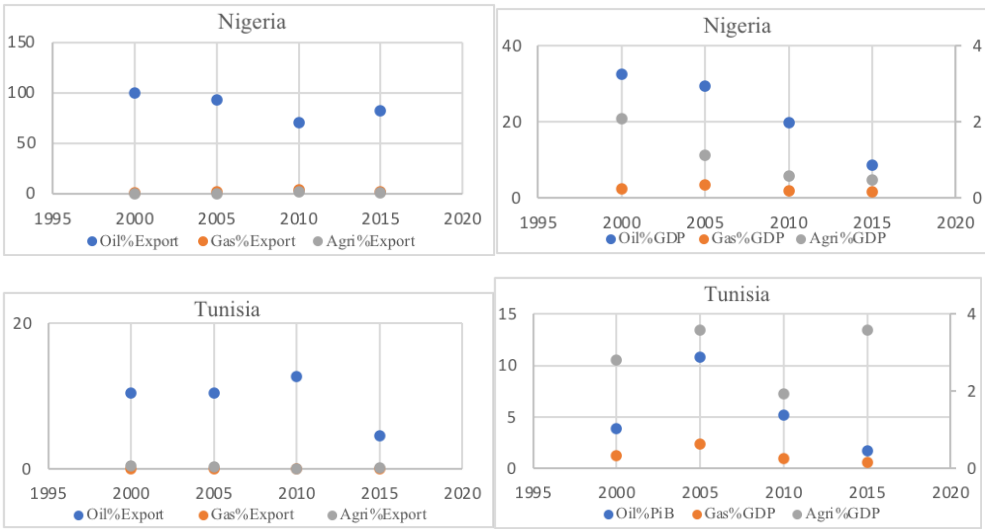
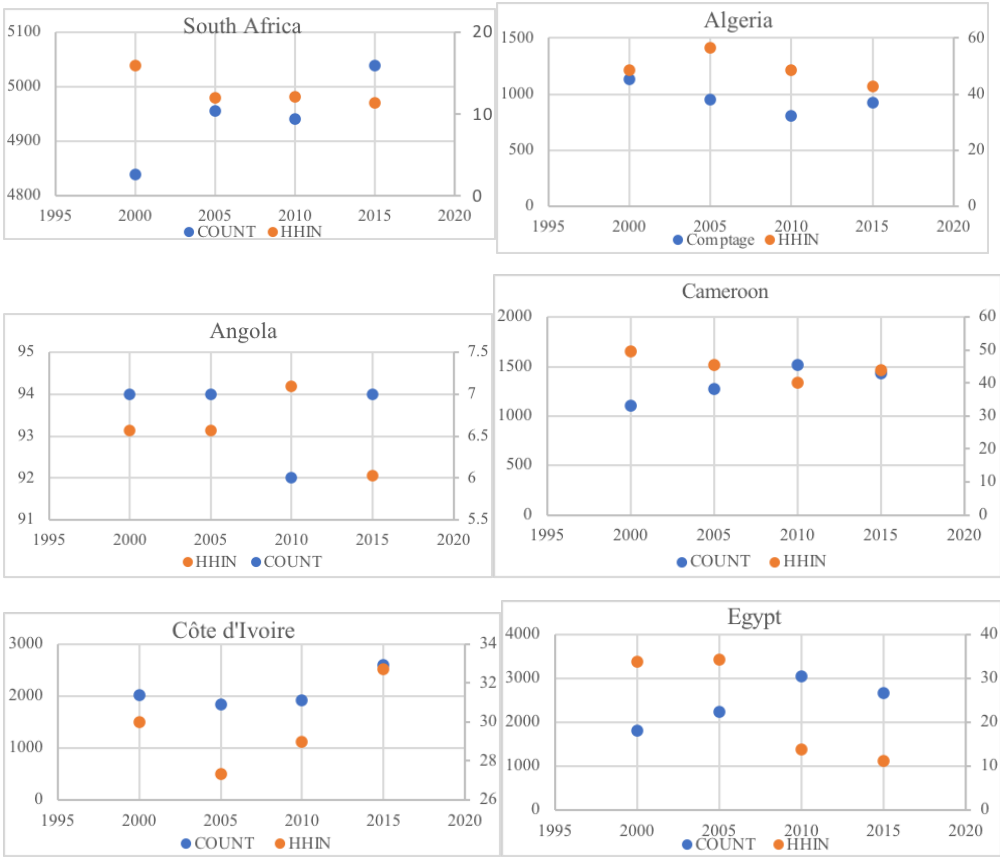
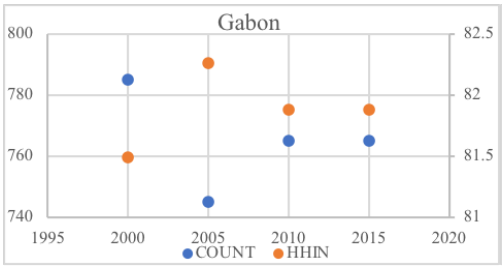
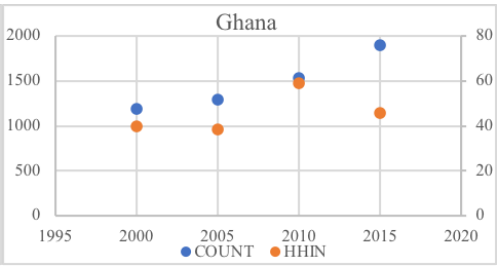
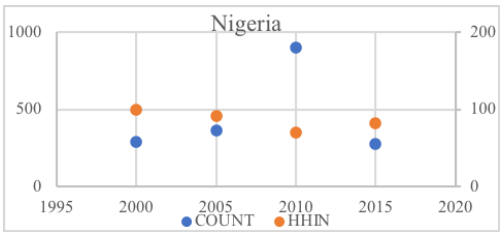


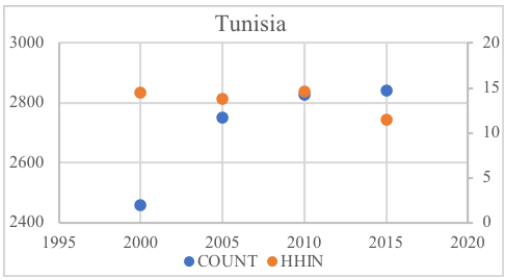
Figure B2: Repartition of diversification indicators




Gabon
800
780
760
740
82.5
82
81.5
81
1995
2000
2005
2010
2015
2020
COUNT
HHIN


Ghana
2000
1500
1000
500
0
80
60
40
20
0
1995
2000
2005
2010
2015
2020
COUNT
HHIN


Nigeria
1000
500
0
200
100
0
1995
2000
2005
2010
2015
2020
COUNT
HHIN


Tunisia
3000
2800
2600
2400
20
15
10
5
0
1995
2000
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COUNT
HHIN

Mission

To strengthen local capacity for conducting independent, rigorous inquiry into the problems facing the management of economies in sub-Saharan Africa.

The mission rests on two basic premises: that development is more likely to occur where there is sustained sound management of the economy, and that such management is more likely to happen where there is an active, well-informed group of locally based professional economists to conduct policy-relevant research.

Bringing Rigour and Evidence to Economic Policy Making in Africa

- Improve quality.
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