Structural Transformation and Economic Growth in Africa: An Economic Complexity Approach

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Abstract: Africa possesses potent structural factors that are significant for the successful structural transformation of its economy. However, the African manufacturing sector remains small compared those in other developing regions. This paper aims to tackle the issue of structural transformation in the African context through an analysis of the economic complexity concept. First, panel data regressions employing the random effects model have revealed a positive and significant empirical link between economic complexity and prospective economic growth. The importance of economic complexity for future growth led us to utilize an ordered Probit model. Our results showed that certain factors, such as R&D efforts, human capital via education, and government effectiveness, positively influence the likelihood of achieving an advanced complexity class.

Keywords: Structural transformation, economic complexity, productive capacities, ordered Probit.
JEL Classification: C23, L5, N67, O14.

INTRODUCTION

Today, sustained long-term economic growth and development necessitate the structural transformation of the productive structure (Hidalgo et al, 2007; McMillan and Rodrik, 2011; IMF, 2014; Lin, 2012; Gaglio, 2017; Lectard, 2017; Haroon, 2019). However, the limited evidence of this structural transformation is a major source of concern for the development trajectory of Morocco and middle-income countries generally. Since the seminal works of Imbs and Wacziarg (2003) and Hausmann et al. (2007), export diversification and sophistication have emerged as the two indicators for measuring and qualifying the structural transformation process. In this context McMillan et al. (2014) stress that increasing productivity and overall income necessitate a structural transformation of the country's economy, that is, transitioning from low-productivity primary sectors to more productive, high-value-added sectors.

Taking this into account, it is accepted that successful structural transformation and gains in competitiveness require a continued quest for diversification into product classes with a certain level of sophistication and technology content. The most competitive countries exhibit a more substantial presence in exports of products with high value added and higher technology content, whereas the least competitive countries remain confined to less dynamic product categories with a low degree of transformation or relatively low technology content. This means that there is a close correlation between the level of competitiveness of an economy and the dynamics of its structural transformation. The latter refers to a country's ability to shift its production structure from low-productivity activities to those with higher productivity. Thus, differences in the pace of economic transformation between countries play a determining role in explaining divergences in economic development trajectories.

In the African context, African economies have become deindustrialized as the reallocation of labor has shifted to the service sector characterized by informality, low productivity, and its inability to create decent jobs[1] , thus limiting the growth potential of the manufacturing sector. However, to enhance overall productivity and incomes, a structural transformation of the country's economy is required, while shifting from low-productivity primary sectors to more productive, high-value-added sectors (McMillan et al., 2014). Thus, the African manufacturing sector, only accounted for 14.3 percent of GDP in 2019 (African Development Bank, 2019). Indeed, the limited structural changes that Africa has experienced in the last decade are a major source of concern for the development trajectory of African countries. To this end, this study examines the issue of structural transformation of African countries in relation to the capacity of economies to diversify while moving upmarket; this analysis will be conducted based on the concept of economic complexity introduced by Hausmann and Hidalgo (2009). Particular attention will also be paid to the difficulties encountered by countries with intermediate complexity as explanatory factors of the middle-income trap.

1. OVERVIEW OF THE LITERATURE

The pioneers of development economics were concerned with describing structural change as a process of migration of the factor of production, "labor", from the primary sector to the manufacturing sector; hence the underlying question

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[1] The service sector contributes over 80% of GDP and employment, while industry accounts for only 15%.

of the production that creates economic growth. The relationship between diversification and income was first studied in 2003 with Imbs and Wacziarg's seminal article, "Stages of diversification". Imbs and Wacziarg (2003) state that the relationship between sectoral diversification of exports and the evolution of income per capita differs according to the level of development reached by the economies. Indeed, during the early stages of a country's economic development, the specialization mechanism is guided by the exploitation of available natural resources and factor endowments. Thus, high-income countries relocate production requiring factors of production that they no longer possess in abundance and specialize in technology- and R&D-intensive activities. On the other hand, countries far from the technological frontier, having accumulated few factor endowments, have little opportunity to diversify, but have access to technologies already developed in high-income economies (Klinger and Lederman, 2011). Innovation consists of the introduction of new intermediate products into the production process and the creation of new products globally. As economies grow, they approach the technological frontier, so the innovation process will mutate from imitation to the introduction of new goods. Thus, the positioning of a country in relation to the technological frontier necessarily impacts its innovation process. Moreover, developed countries that already have a diversified productive structure have fewer opportunities for diversification than developing economies (Cadot et al, 2011). As a result, it seems that the force of diversification dominates low-income countries, whereas the force of specialization dominates high-income countries. The reallocation of productive resources between sectors perpetually modifies the comparative advantages of countries following the diversification process. Second, the international export market is reconstructed in terms of the evolution of the relative market shares of each country. In the early stages of economic development, diversification consists of the introduction of new products, and as development proceeds, it moves towards a reconcentration of export activities. In the first case, export growth takes place on the extensive margin and consists of a variation in the number of new exported products or a variation in the number of new export destinations. In the second case, export growth occurs on the intensive margin; it consists of a variation in the value of existing exports. Klinger and Lederman (2006) state that the extensive margin declines with economic development, it is therefore more frequent in less developed economies. Indeed, when a new export appears, it initially contributes little to export growth. Over the years, it will shift to the intensive margin.

Diversification appears to be an inherent process in economic development (Cadot et al, 2011). In this vein, Xiang (2007) suggests that along a country's economic development path, a transitional change in the diversification process, in terms of sectoral specialization, takes place. During this phase, new specializations arise, while the old ones still exist. As a result, foreign sales diversify and the number of exported products increases. Gradually, this process tends to readjust itself, so that the comparative advantage shifts from the old specializations to the new production and the diversification of exports decreases. As a result, the interaction between economic development of countries and the diversification of exports is explained by this process in which economies move from one cone to another. In contrast, McMillan and Rodrik (2011) introduce the notion of "*structural mistransformation*", meaning structural change of the "*growth reducing*" type. McMillan and Rodrik (2011) illustrate the example of Sub-Saharan Africa where the labor factor has shifted from more productive activities to less productive activities, particularly informal ones.

Hausmann et al (2007), in their pioneering article "What you export matters", have empirically proven that country specializations have considerable effects on the level of economic development. Some productions are therefore more promising than others. Thus, the differences between countries in terms of productivity, wealth creation and therefore in terms of GDP per capita could be explained by differences in economic complexity. Hidalgo and Hausmann (2009), then Hausmann and Hidalgo (2011) present economic complexity as a dual-component structure: country/products, within which countries are connected to the products they export. This structure is the result of an initially tripartite structure: country/productive capacities/products. In other words, the country/productive capacities pair expresses each country's endowment of productive skills, and the productive capacities/products pair designates the technological content introduced into the exported goods. The links between countries and products thus provide information on the availability of an economy's productive capacities. In the economic literature, there is no exhaustive list of these productive capacities. However, Hidalgo and Hausmann give them a non-market or non-tradable character.

In order to build a sophisticated and diversified productive structure within a country, the approach of Hidalgo and Hausmann (2009) and Hausmann and Hidalgo (2011) builds a theory of accumulation of productive capacities through two processes. First, a process through which nations discover new products as a result of the interaction of the initial productive skills at their disposal (a very diverse stock of knowledge, know-how and capabilities within an economy, of which each individual holds a limited share). Second, a process through which nations combine new productive skills with old ones to produce new goods. This process will then depend on the interactions and complementarities between these individual capabilities that can be combined through complex organizations, particularly firms and markets. According to Hidalgo and Hausmann (2009; 2011), economic complexity thus explains the differences observed between countries in terms of economic development.

Given the empirical difficulty of exhaustively defining the productive capacities available to a country and the degree of interaction between them, Hidalgo and Hausmann (2009; 2011) define two indicators of economic complexity, the first relating to products, the second relating to the country. These indices are estimated through the so-called reflection method, which is a joint and iterative calculation of the diversification indices of a country and ubiquity of a good. The ubiquity of products explains the complexity of their production process. High-ubiquity products are exported by several countries, regardless of the country's level of development and capabilities. In contrast, low ubiquity products are exported by a few countries, because their production may re-

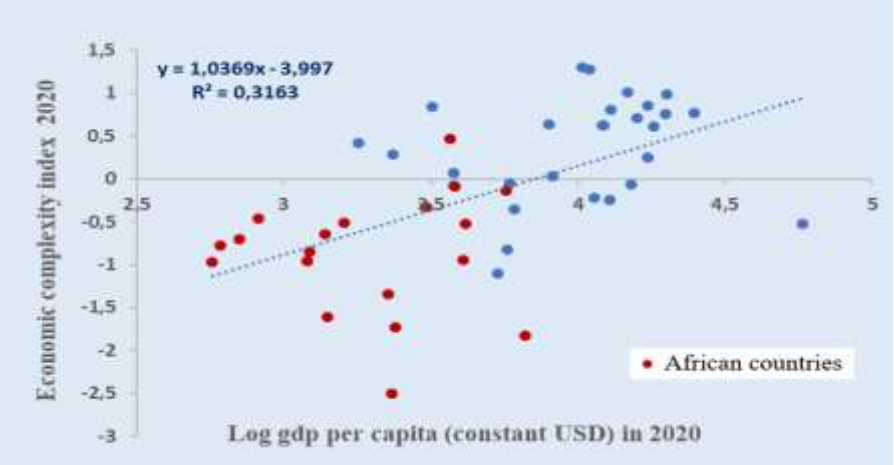

Fig. (1). Relationship between economic complexity and GDP per capita.
Source: based on data from The Economic Complexity Observatory for ECI and the World Bank's WDI for GDP per capita.

quire a plethora of productive capacities or scarce factors of production, available in few countries. Thus, low ubiquity is justified either by the sophistication of the production process, in which case the good in question is complex. Or by the scarcity of production capacities, with few countries possessing all the factors of production necessary to produce it. In this case, the product is considered less sophisticated. As the diversification index reflects the accumulation of productive capacities, Hausmann and Hidalgo include the level of diversification of these products in order to distinguish between these two cases. In line with the positive correlation between diversification and income level, the authors assume a positive relationship between the accumulation of productive capacities and export diversification. Thus, if a product with low ubiquity is exported by countries with concentrated exports, then low ubiquity is explained by the scarcity of a factor of production. The good in question is therefore not very complex. On the contrary, countries that produce diversified goods have accumulated varied productive capacities; the ubiquity of the good is then explained by the complexity of its production; the product in question is complex. Consequently, indicators of the complexity of a country and its products highlight the goods that the country must produce and export in the future, based on its initial productive capacities.

At the country level, the complexity index is measured by the diversity of the export basket corrected by the ubiquity of its component products. Countries with diversified exports in products with low ubiquity are countries that have accumulated diversified skills. These countries have a high level of complexity. On the other hand, if the export basket is composed of goods that are certainly diversified, but with high ubiquity, then the country has a low level of complexity. In the country approach, the level of diversification of the export basket is corrected by the ubiquity of the products in it. Thus, the level of economic complexity of an economy indicates the goods it must produce in the future. A product that requires a large set of productive skills will be accessible by a few countries, which is explained by its low ubiquity. However, an economy that has many productive capabilities will produce more goods by combining new productive skills with old ones, this indicates high diversification. From this, we conclude that the diversification of an economy increases with the number of capabilities it holds, while the ubiquity of products decreases with the number of available skills.

The economic complexity index then makes it possible to classify countries according to the level of complexity as revealed by their export portfolios. It is a standardized variable for each year and therefore represents a relative measure. The interest of this index is when it is analyzed in relation to the level of development, as reflected by GDP per capita. Fig. (**1**) illustrates the relationship between economic complexity and GDP per capita growth at purchasing power parity in middle-income countries. It shows that the higher the level of economic complexity of a country, the higher its income level will tend to be.

Within the African continent, countries that are "major exporters" of manufactured goods, namely Tunisia, South Africa, Egypt, and Morocco, (exhibit) have higher levels of economic sophistication in manufacturing sectors than other countries in the same region. Thus, it could be suggested that that these "manufacturing frontier economies" have the potential to become regional manufacturing hubs. However, when compared to other, better-performing countries globally, Africa's primary manufacturing exporters have lower levels of economic sophistication. The relatively low levels of economic complexity in the remaining African countries imply limited productive capacities, which has implications for the ability of these economies to acquire more productive capacities needed for engaging in more complex manufacturing activities. Indeed, the work of Hausmann and Hidalgo has shown, through analyses of a large panel of countries, that economic complexity has a positive and significant effect on the future growth of GDP per capita. This positive relationship is explained by the fact that economies tend to converge towards a level of income per capita that is consistent with their productive capacities and their intrinsic knowledge, i.e. their degree of economic complexity. Thus, when a country has an income level that is inconsistent with its level of complexity, this leads to either an upward catch-up or a downward correction in GDP per capita, which affects the future growth rate of that economy.

2. COMPLEXITY AND ECONOMIC GROWTH TRAJECTORY

Hausmann and Hidalgo's work has shown that a country's economic complexity plays an important role in economic growth and country catch-up. In addition to the positive empirical correlation between the economic complexity indicator and the level of GDP per capita, their research also showed that progress in economic complexity has a significant and positive impact on the future growth of GDP per capita. The authors argue that the positive relationship between a country's level of income per capita and its degree of economic complexity is explained by the fact that economies tend to evolve towards a level of income that is consistent with their productive capabilities and intrinsic knowledge.

2.1. Methodology and Data

The objective of this section is to estimate the empirical relationship between the Economic Complexity Index (ECI) and Gross Domestic Product (GDP) per capita growth. The basic model we use is an equation based on the Barro model, estimated on a panel of 47 African and non-African countries[2] during the period 1995-2020. In the chosen specification, the average annual growth rate of GDP per capita is explained by the initial level of GDP per capita; the level of the ECI at the beginning of each period; the benefits from natural resources available in each country; and a vector (X) of variables, traditionally recognized as determinants of long-term growth. In particular, these are the investment rate to take into account the effect of physical capital accumulation, the population growth rate and the higher education enrollment rate at the beginning of each period. All the variables used in our study, with the exception of the Economic Complexity Index (ECI) from "The Atlas of Economic Complexity", are obtained from the World Bank's World Development Indicators.

$$gY_{i,t+1} = \beta_0 + \alpha_1 Y_{i,t} + \alpha_2 ECI_{i,t} + \sum_{j=3}^{n} \alpha_j X_{i,t}^{j} + Africa + \delta_i + \gamma_t + \epsilon_{i,t}$$

With:

i, country index and *t*, year index

$gY_{i,t+1}$: annual growth rate of GDP per capita between *t and t* +1.

$Y_{i,t}$: log of GDP per capita in constant 2015 dollars

ECI: Economic Complexity Index

X: vector of Growth determinants (annual population growth rate, investment rate, higher education enrollment rate, benefits from the natural resources available to each country)

Africa: dummy variable that captures the African effect. It takes the value 1 if country i belongs to the African continent and 0 otherwise.

The estimates in this study use a different econometric method than the one used in the original work by Hausmann and Hidalgo. The most common method of estimating panel data is to use within (fixed effects) and between (random effects) estimators to control for country-specific unobservable effects. In fact, in panel data estimations, the problem of heterogeneity induced by the presence of fixed effects specific to each individual/country can lead to biased coefficients since the effect of these omitted variables, captured by the error term, is correlated with the explanatory variables of the model. One possible solution to this problem of omitted variables is to estimate regressions with fixed or random effects. The random effects model assumes that the unobservable component is randomly distributed; the estimator of this model is based on a strong assumption; that of strict exogeneity of the explanatory variables, i.e. that the correlation between the individual effects and the regressors is zero, hence the difficulty of its application, while the fixed effects model is less restrictive, it assumes that the unobservable heterogeneous component is constant through time.

2.2. Results and Interpretations

The results obtained from the different estimated models (Table **1**) indicate a positive and significant impact of the economic complexity index on future economic growth, in line with the findings of Hausmann and Hidalgo, albeit with differences in coefficient size. Differences in the control variables used may explain these differences. It should also be noted that the effect of economic complexity remains largely significant even after the introduction of the different control variables.

The estimates of the parameters associated with the variables of GDP per capita in the initial period and the level of education are also significant and with signs consistent with theory. Indeed, the level of GDP per capita at the beginning of the period displays a negative sign reflecting the catching-up effect between the less developed and the more advanced countries. Moreover, the tertiary education enrollment rate has positive coefficients reflecting a positive impact on GDP per capita growth. The estimated coefficient on the investment rate is consistent with theoretical expectations that structural transformation of an economy requires high levels of investment in areas such as advanced technologies, new productive capacities, labor force skills, and institutional reforms. To make a successful transition to a more advanced economy, it is necessary to attract domestic and foreign investment, mobilize financial resources to support investment projects, and adopt investment-friendly policies.

On the other hand, population growth emerges with a non-significant coefficient. Similarly, the variable indicating the benefits from natural resources appears counterintuitive and close to zero, probably confirming the absence of a link between the abundance of natural resources in a country and its economic growth. Indeed, the podium of developed countries at the global level does not enjoy an abundance of resources. The Africa dummy variable turns out to be negative and statistically insignificant, suggesting that once a country's ex-

[2] Initial estimates are made on the basis of a sample of African countries using the fixed effects estimator to study the determinants of economic complexity. However, the data available for African countries over the study period was a very small sample, and economic complexity in African countries is generally at the lower end of the distribution for all countries. Thus, to obtain more robust results, non-African countries were included.

Table 1. Estimation Results of the ECI GDP Per Capita Growth Relationship.

Random Effects Model			
Dependent Variable: Average Annual Growth of GDP Per Capita in PPP $gY_{i,t+1}$			
GDP per capita $Y_{i,t}$	-1.257 (0.000)	-1.934 (0.002)	-2.086 (0.001)
Economic complexity index $ECI_{i,t}$	1.051 (0.000)	0.684 (0.020)	0.632 (0.050)
Benefits from natural resources (% of GDP) $RN_{i,t}$	0.016 (0.284)	0.0264 (0.205)	0.004 (0.816)
Investment rate $INVEST_{i,t}$		0.224 (0.000)	0.220 (0.000)
Higher education enrollment rates $EDUC_{i,t}$		0.013 (0.001)	0.013 (0.001)
Population growth rate $GPOP_{i,t}$		-1.072 (0.232)	-1.073 (0.255)
Africa			-0.167 (0.635)
R^2 adjusted	32.7	38	43.4
Number of countries	47	47	47
Observations	1213	1000	1176

P-values in brackets.

port structure and economic complexity are taken into account, the "negative Africa effect" disappears. This reveals that once a country's productive capacities and the potential they offer for increasing its manufacturing activity are taken into account, the economic growth of African countries no longer underperforms compared to other countries in the world. Therefore, if African countries were able to develop the productive capacity to ensure sustained economic growth, products exported from Africa to the rest of the world would be more competitive, thus being able to compete in the international market.

The results confirm that the level of economic complexity of a country influences its future growth path. Moreover, these results suggest that the development gaps observed between countries can be explained by the differences in their economic complexity. The findings of this study thus corroborate the results found by Hausmann and Hidalgo, who argue that each economy tends to converge to a level of income per capita that reflects its level of economic complexity, i.e., its capabilities in terms of knowledge and know-how.

3. FACTORS FOR IMPROVING ECONOMIC COMPLEXITY: AN EMPIRICAL STUDY

The results obtained in the previous section support the positive relationship between economic complexity and the structural transformation of an economy. This leads us to ask a main question: how can an economy accumulate the productive and cognitive capacities necessary to improve its level of complexity? It is important to note, however, that empirical studies on the determinants of economic complexity are scarce (Hidalgo and Hausmann, 2009; Daude, Nagengast and Perea, 2014; Blyde, 2014; Regional Economic Outlook: Asia and the Pacific, 2015: El mokri, 2016).

3.1. Methodology and Data

Although the theoretical determinants of economic complexity are not clearly defined, we rely mainly on the general definition adopted by Hausmann and Hidalgo. According to them, the economic complexity of a country is related to its ability to accumulate and combine a set of productive and cognitive capabilities, mainly non-market ones. These capabilities include: advanced infrastructure would facilitate the installation of investors and the densification of production units for higher value-added products; the quality of human capital is a key element that would improve the capacity to absorb and master new technologies needed to strengthen the selective diversification into more sophisticated sectors; research and development efforts; and the quality of institutions, which would allow for a better combination of productive capabilities through the efficient functioning of markets for goods and services, labor and capital.

Before proceeding to the modeling, we discretized the economic complexity index variable into 3 categories, namely: low complexity, intermediate complexity and high complexity. There are several discretization techniques, in this work we opted for the equal widths (amplitudes) interval method. The ordered Probit model is a statistical approach used to model the factors that influence the probability of a country falling into one of the three categories of economic complexity previously defined using a latent variable regression based on the Probit distribution function. In this model, the dependent variable is a categorical variable with a natural ordering, taking values from 1 to 3 to represent the levels of low, intermediate, and high complexity respectively (Low complexity = 1; intermediate complexity = 2; high complexity = 3). The ordered Probit model is estimated based on a latent variable regression y^* such that:

$$y^* = X'\beta + \varepsilon$$

The vector X' contains the explanatory variables for the probability of belonging to each of the three categories of economic complexity. The variable representing human capital is the gross enrollment rate in higher education. We chose to use the ratio of research and development (R&D) expenditures to gross domestic product (GDP) as an indicator of innovation capacity. For the advanced infrastructure variables, we opted for the Internet subscriber rate (% of population). Net Foreign direct investment (FDI) inflows relative to GDP are introduced to account for the role of foreign investors as a source of technology and know-how. Finally, the "quality of the institutional environment and the functioning of markets" dimension is captured through three variables: the "Labor Market Regulation" index, which measures the flexibility of the labor market, the government efficiency index, and the density of new businesses created (per 1,000 people aged 15-64) in order to measure a given country's ability to provide an environment conducive to business and entrepreneurship. With the exception of the ECI, which is sourced from The Atlas of Economic Complexity, and the Labor Market Regulation index from the *Economic Freedom of the World database*, all other variables are from the *World* Bank's *World Development Indicators.*

In the Probit model, the relationship between the observed variable y and the unobserved variable y* follows the following rule:

$$Y = \begin{cases} 1 \text{ if } y^* \leq \mu_1 \\ 2 \text{ if } \mu_1 \leq y^* \leq \mu_2 \\ 3 \text{ if } y^* > \mu_2 \end{cases}$$

The thresholds μ_i are estimated simultaneously with the β coefficients of the model, while the error term is assumed to follow a normal distribution in accordance with the principle of Probit models. The different probabilities of belonging to the three categories of economic complexity are estimated as follows, based on cumulative distribution functions φ:

$$P(y = 1|X) = \varphi(\mu_1 - X'\beta)$$

$$P(y = 2|X) = \varphi(\mu_2 - X'\beta)$$

$$P(y = 3|X) = 1 - \varphi(\mu_2 - X'\beta)$$

However, the coefficients obtained from the Probit model are not easily interpretable, unlike the linear regression models. To remedy this problem, we will calculate the marginal effects, which allow us to measure the impact of an additional unit of each explanatory variable on the three probabilities of belonging to the different complexity categories described above. Since the economic complexity indicator is a standardized variable by default, we opted for a standardization of all the explanatory variables (except for the variables relating to government efficiency and labor market flexibility), by subtracting from each variable its cross-sectional mean and dividing it by its standard deviation. Thus, the Probit model was estimated in cross-section on a sample of nearly 47 countries, over a period of 10 years. The explained variable "y" provides information on whether each country belongs to one of the three complexity categories in 2020, while the explanatory variables are observed at the beginning of the period, in 2010. The choice of a 10-year interval was justified by the desire to take into account the slow transition process from one complexity category to another.

3.2. Results and Interpretations

Table **2** presents the results of the estimation of the ordered Probit model. The Chi-2 test shows that the probability of the likelihood ratio is 0.00 which is below the 1% threshold. This means that at least one of the explanatory variables has an effect significantly different from zero on the dependent variable. The significance level of the explanatory variables in question is 5%. In the first part of the table, the results show that 4 of the 7 variables have a significant impact on the degree of economic complexity. These variables include the ratio of R&D expenditures to GDP, the gross enrollment rate in higher education, the government effectiveness indicator, and the infrastructure access indicator reflected by the internet user rate.

It is important to note that the coefficients of ordered Probit models are not directly interpretable as in simple linear regression models. To overcome this limitation, we chose to follow a common practice by computing marginal effects. These marginal effects allow us to understand the impact of an additional unit of each explanatory variable on the probabilities of belonging to each of the three categories of economic complexity. In this analysis, we are primarily interested in interpreting the differences in marginal effects between the intermediate and high complexity categories.

The estimation results presented above show that increasing the R&D expenditure ratio by one additional unit relative to the sample average decreases the probability of being in the intermediate complexity class and increases the probability of being in the high complexity class by about 30 percentage points. This result underlines the importance of R&D efforts to enable a country to progress from the intermediate complexity class to the global technological frontier and to improve the complexity level of its exportable offer. Indeed, innovation helps to strengthen the contribution of total factor productivity to economic growth and to increase a country's productive capacity, enabling it to position itself in the most complex and high value-added sectors.

At the same time, the results show that the gross enrollment rate in higher education has a significant effect on a country's likelihood of being positioned in the high complexity category by almost 52 percentage points. This supports the idea that a high level of tertiary enrollment is a key indicator of a country's ability to absorb and apply new knowledge and technology, which in turn develops expertise and tacit know-how that can be used in the production of more complex products and helps improve its economic complexity and global market position.

Table 2. Estimation Results of the Ordered Probit Model.

LR Chi2(7) = 38.04 **Prob > Chi2 = 0.0000** **Log likelihood = -25.972377** **Pseudo R^2 = 0.4227**				
Variables	**Coef.**	**Std. Err**	**z**	**P>z**
Government effectiveness	0.393	0.409	0.96	0.041
Internet users	-0.496	0.547	-0.91	0.050
Gross enrollment rate in higher education	1.469	0.489	3.01	0.003
Net FDI inflows to GDP	-0.152	0.229	-0.66	0.507
Density of new businesses	-0.0657	0.346	-0.19	0.849
R&D expenditure to GDP	0.839	0.363	2.31	0.021
Labour market flexibility	0.011	0.166	0.07	0.946
Marginal effects				
Variables	**Coef.**	**Std. Err**	**z**	**P>z**
Low complexity				
Government effectiveness	-0.009	0.013	-0.72	0.473
Internet users	0.012	0.017	0.70	0.481
Gross enrollment rate in higher education	-0.035	0.035	-1.03	0.305
Net FDI inflows to GDP	0.004	0.006	0.56	0.575
Density of new businesses	0.002	0.009	0.19	0.853
R&D expenditure to GDP	-0.020	0.021	-0.97	0.333
Labour market flexibility	-0.0002	0.004	-0.07	0.947
Intermediate complexity				
Government effectiveness	-0.141	0.149	-0.95	0.045
Internet users	0.178	0.201	0.88	0.050
Gross enrollment rate in higher education	-0.527	0.204	-2.58	0.010
Net FDI inflows to GDP	0.054	0.083	0.66	0.512
Density of new businesses	0.023	0.124	0.19	0.849
R&D expenditure to GDP	-0.300	0.143	-2.10	0.036
Labour market flexibility	-0.004	0.059	-0.07	0.946
High complexity				
Government effectiveness	0.150	0.156	0.96	0.054
Internet users	-0.189	0.211	-0.90	0.055
Gross enrollment rate in higher education	0.562	0.193	2.91	0.004

Net FDI inflows to GDP	0.058	0.088	-0.66	0.510
Density of new businesses	-0.025	0.132	-0.19	0.849
R&D expenditure to GDP	0.321	0.142	2.26	0.024
Labour market flexibility	0.004	0.063	0.07	0.946

The marginal effect of the variable "government effectiveness" is also significant, decreasing the probability of being in the intermediate complexity category and increasing the probability of moving to a high complexity category by almost 15 percentage points. This result is consistent with the empirical literature that shows that countries with efficient institutions that provide a conducive business environment encourage investors to undertake long-term investments and reduce their risk aversion. Similarly, a country with strong institutions tends to specialize in more sophisticated and innovation-intensive products (Hausmann et al 2007, Nunn in 2007). Similarly, the marginal effect of the internet user rate (% of the population) emerges as significant. This result shows the effect of the availability of advanced infrastructure on economic complexity by facilitating the access of businesses to advanced technology services. Thus, the impact of an additional unit of this variable increases the probability of being in the intermediate complexity category by about 18 percentage points and reduces the probability of being in the advanced complexity category. This is because during economic development there is a relationship between economic complexity and growth phases. Initially, developing economies reach an intermediate level of complexity by providing a welcoming infrastructure for domestic and foreign investors, which allows them to adopt and imitate existing foreign technologies. This contributes to their increased economic complexity. However, once productive and cognitive capabilities are enhanced, the importance of advanced infrastructure diminishes in favor of other factors such as human capital, research and development, and institutional quality, which are essential to boosting economic complexity to higher levels.

Regarding the other variables of the model, it should be noted that the ratio of foreign direct investment flows to GDP shows an insignificant marginal effect. Given that previous empirical studies have reached conflicting conclusions, it is not surprising that the ratio of foreign direct investment flows to GDP did not show statistical significance in our model (Hale and Long 2011, Takii 2005, Karpaty and Lundberg 2004, Wang and Zhao 2008, Khawar 2003, Barbosa and Eiriz 2009). This insignificance can be explained by several factors such as the technology gap between foreign and domestic firms, as the larger the gap, the less domestic firms are able to absorb the potential externalities of FDI. Moreover, the quality of human capital in the recipient country may be low, which hampers the positive effects of technology transfers. At the same time, the model shows that labor market flexibility has a non-significant effect (at the 5% level) on improving the level of economic complexity of countries. The last variable in the Probit model, firm density, does not show a significant marginal effect. This result might seem counter-intuitive given that entrepreneurs are supposed to contribute to increasing economic complexity through their ability to optimally combine production factors and the various capacities available in the economy. It should be noted that the insignificant coefficient obtained for this variable is largely due to its inability to measure the quality of entrepreneurship since it is rather a measure of quantity (density). This does not detract from the well-established importance of entrepreneurship in the theoretical and empirical literature regarding economic growth, innovation and productivity.

CONCLUSION

This work aims to study the structural transformation process of African countries by exploiting the concept of economic complexity introduced by Hausmann and Hidalgo (2007). In the second section, we endeavored to confirm the results these two authors obtained concerning the link between economic complexity and GDP per capita growth, using a panel of both African and non-African countries. The results obtained confirm the conclusions of Hausmann and Hidalgo and show a positive and significant impact of economic complexity on GDP per capita, even after introducing other explanatory variables into the model. These results thus support the hypothesis that an economy's structural transformation path is conditioned by its available productive capacities and cognitive skills. In the third part of the work, we looked at the factors that can determine the positioning of countries in the three categories of complexity: low, intermediate and high. The results obtained were consistent with the conclusions found in the theoretical and empirical literature. Indeed, the model shows that improvements in human capital through education, R&D and institutional quality, increase the probability of being in the high complexity category, while access to information and communication infrastructure only has a positive effect on the probability of being in the intermediate complexity class. The model does not find significant direct effects of FDI, labor market flexibility, and new firm density, which could be explained by the fact that there may be other factors that condition and impact, including the absorptive capacity and the degree of integration with the local productive fabric, as well as the lack of an adequate institutional framework capable of providing an enabling environment for foreign investors and new firms. On the other hand, it is worth mentioning that the estimates of the Probit model were made on cross-sectional data, which does not allow for the dynamic interactions between economic complexity and its determinants, nor does it account for country-specific effects. One possible improvement to be considered in future work would be to estimate an ordered Probit on panel data.

Based on the diagnostic results listed in the previous sections and drawing on the lessons learned from the experience of some successful countries, some proposals have been identified to accelerate the structural transformation process of African countries in the light of economic complexity. These proposals are articulated around three interrelated points:

Capitalizing on Opportunities Across all Sectors

Optimizing new sources of growth on the African continent would open up new prospects in terms of broadening the spectrum of national wealth and creating sustainable jobs. In the primary sector, some industries, including agri-food, could be a major growth lever, improving the living conditions of rural populations. Enhancing upstream-downstream integration of the agri-food industry into global production networks, and adapting to international market standards, would bolster the export performance of this industry. In the industrial sector, the competitive redeployment of this sector would give new impetus to the dynamics observed recently and broaden the production base to further diversify its export basket.

Moreover, investors often face the significant obstacle of the self-discovery process when it comes to new products. Thus, industrial policy should also focus on measures to reduce the uncertainty associated with this process:

- To reduce the uncertainty surrounding the new markets to be explored. The industrial policy should fill the information gap among potential investors about the new market to be discovered in terms of knowledge of the structure of the market in question, as well as the process of mastering the new technologies necessary for the production of new sophisticated products.
- Reduce the information asymmetry of the financial sector. Access to finance is a barrier that can limit the ability of entrepreneurs to venture into new and more complex products, especially given the degree of risk aversion of banks.

Fostering a Transition Towards a New Industrialization Path

A successful industrialization strategy will accelerate the economic convergence of African countries towards the circle of emerging countries. This strategy should focus more on trade policy interaction and foreign direct investment attractiveness, while creating an environment conducive to the internationalization of small and medium-sized industries. Particular attention should be paid to the green economy in order to mobilize the potential of these promising sectors and to ensure that African industrialization strategies are fully consistent with the requirements of environmental sustainability.

On the other hand, the successful integration of African economies into global production networks requires the upgrading of the industrial fabric and the emergence of local value chains, via existing ecosystems or those to be created. Thus, minimum criteria must be required of all investors in all industrial sectors, to promote the transfer of knowledge and technology and allow the emergence of a high-performance industrial fabric. These market failures are generally among the main reasons raised in the literature to justify the use of industrial policies[3].

Boosting Investment in R&D and Innovation

In accordance with the recommendations generally intended for developing countries, the quality of human capital is an indispensable factor in facilitating the structural transformation of the national economy and placing it on a solid and sustainable footing. Among the measures recommended in this regard are:

- The promotion of both initial and continuing training in technical fields, support for research and innovation, and partnerships between the private sector and the academic sphere are all structuring projects that can promote the structural transformation of African countries.
- The process of discovering new products requires important resources that can be constraining for small or medium-sized companies. The purpose of these resources is to study the new markets to be explored, acquire new technologies and strengthen the human capital in order to adapt the company's human resources to the new targeted sectors.

APPENDIX

List of Countries	
1. Angola	2. Argentina
3. Australia	4. Burkina Faso
5. Bulgaria	6. Brazil
7. Chile	8. China
9. Cameroon	10. Colombia
11. Croatia	12. Ecuador
13. Egypt	14. Estonia
15. Gabon	16. Greece
17. India	18. Indonesia
19. Ivory Coast	20. Jordan
21. Kenya	22. Lithuania
23. Latvia	24. Morocco
25. Mongolia	26. Mozambique
27. Namibia	28. Nigeria
29. Panama	30. Peru
31. Philippines	32. Poland
33. Portugal	34. Paraguay
35. Romania	36. Rwanda

3 Hausmann and Rodrik (2003) followed by Hausmann et al. (2007), introduced a «Cost Discovery Model» to demonstrate the inability of private entrepreneurs to explore new products. This model explains why the market alone cannot promote rapid transitions towards more complex products.

37. Saudi Arabia	38. Senegal
39. South Africa	40. Spain
41. Togo	42. Tunisia
43. Turkey	44. Ukraine
45. Uruguay	46. Zambia
47. Zimbabwe	

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