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# **Entry into Formal and Informal Entrepreneurship and Sustainability Goals: The Need for Innovative and Institutional Solutions**

Adel Ben Youssef, Sabri Boubaker, , Anis Omri,

## **Abstract**

The relationship between entrepreneurship and sustainable development has received considerable attention from academics and policymakers, as society searches for solutions leading to sustainability. The role of innovation and institutional quality in reaching sustainability goals is one of the key areas tackled by the current sustainable development debate, particularly in developing countries. Using a modified environmental Kuznets curve model, this study attempts to better improve our understanding of the critical roles of innovation, institutional quality, and entrepreneurship in the structural change toward a sustainable future in Africa. The empirical results show that both formal and informal entrepreneurship are conducive to less environmental quality and sustainability in 17 African countries where the contribution of informal entrepreneurship is much higher compared to the formal one. However, the relationship between entrepreneurship and sustainable development becomes strongly positive when the levels of innovation and institutional quality are higher. This research makes a contribution to this important emerging research area in that it clarifies conditions through which countries and firms in Africa can move toward more sustainable products and services. Formalizing the informal sector can lead to the improvement of the environmental and economic performance.

*Keywords:* Entrepreneurship; Sustainability; Innovation; Institutions quality.

## 1. Introduction

There is a growing awareness that change is required to reduce the negative societal and environmental effects generated by unsustainable business practices (Hall et al., 2010; Stiglitz, 2016)<sup>1</sup>. Entrepreneurship is proposed as a particularly effective practice to make growth sustainable and more inclusive. However, despite the promise entrepreneurship holds for promoting sustainability goals and addressing climate change challenges, there is still great ambiguity regarding the role and nature of entrepreneurship. Moreover, literature on sustainability within the general entrepreneurship literature has thus far been rare (Hall et al., 2010). Accordingly, despite the fact that entrepreneurship has been acknowledged as one possible solution for changes toward more sustainable economies, there remain major gaps in our knowledge of how and whether this transition actually takes place in Africa. At the same time literature focusing on entrepreneurship does not take into account the other key dimensions of the problem such as the quality of the institution, the level of innovation or the trade openness of the economy.

Starting from these considerations, the purpose of this paper is to show how innovation and institutional quality constitute important factors through which entrepreneurship can simultaneously create economic growth and advance social and environmental goals.

To achieve this objective, we follow the methodology proposed by Costantini and Monni (2008) that consists in using two simultaneous models to validate, in the first, the Environmental Kuznets Curve hypothesis (EKC) by incorporating different forms of entrepreneurship in the standard EKC model.

[In order to illustrate our main purposes we apply our methodology to the African Continent.](#) In fact, the ability of the African continent to face many serious challenges, such as climate change depends strongly on its ability to promote new kind of entrepreneurs, to adopt new technologies, to build adequate institutions in order to manage such changes. Prior studies have shown that many of the major killers in Africa are climate sensitive. Without policy intervention, climate change could increase the population at risk of malaria in Africa by 170 million by 2030 (Foresight, 2006) and the global population at risk of dengue by 2

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<sup>1</sup> Answers and solutions thus far undertaken by global policymakers with respect to these sustainability-related challenges have been a subject of discussion in many international conferences organized by the United Nations (especially, United Nations Framework Convention on Climate Change, UNFCCC, in 2012<sup>1</sup>).

billion by the 2080s (Hales et al. 2002). Urban air pollution causes about 1.2 million deaths each year (WHO, 2009), mainly by increasing mortality from cardiovascular and respiratory diseases. Indirect effects of Climate change are also very important. In sub-Saharan Africa, where people rely on rained agriculture, yields could drop by up to 50% by 2020 (Parry et al. 2007), putting millions at risk of food crises and malnutrition (World Bank, 2010). Despite growing understanding of the effect of climate change, the region capacity to address such risks is weak.

We considered 17 African countries over the period 2001–2014 for three main reasons. Firstly, the sample of countries selected is composed of the three types of countries according to the level of development (low income – middle income and emergent countries). Thus it takes into account the wide variety of the situations in Africa. Secondly, the sample of the countries reflects also a large share of the GDP of Africa, which makes our conclusions valid for the large part of Continent<sup>2</sup>. Thirdly, Africa is a fast growing continent. Its population will double during the next three decades passing from 1 billion people to 2,3 billion people in 2050. There is a strong need that African development follow a different path of development than the one of Europe or America. Sustainability of African Economies is the major challenge for the next generations for the entire world.

Our results show, in our first model, the negative contribution of both formal and informal entrepreneurship to environmental quality in Africa. The motivation underlying the inclusion of informal entrepreneurship in our analysis is the size of the informal sector in Africa where more than one-third of small businesses are not legally registered. The integration of various forms of entrepreneurship is certainly one of the notable features of this work. In the second model, we use a modified EKC (MEKC) to analyze the relationship between entrepreneurship and sustainable development using negative genuine savings as the dependent variable. The results show that this relationship is needed for innovative and institutional solutions.

Our paper makes three substantive contributions to the above literature. First, it incorporates entrepreneurship activity into the standard EKC model and demonstrates that environmental quality in Africa is negatively affected by both forms of entrepreneurship, namely survival entrepreneurs and innovative Schumpeterian entrepreneurs. Second, it builds an MEKC model to examine the contribution of entrepreneurship on sustainable development.

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<sup>2</sup> One needs to mention that the availability of the data constraints does not allow us to work on a larger sample since many variables are lacking for several countries.

Third, it appears that while entrepreneurship is currently discussed as an important channel for fostering sustainability, there remains substantial uncertainty regarding the conditions needed to move toward sustainable products and services. This study constitutes a contribution in this direction by incorporating innovation and institutional quality as conditional variables to move toward sustainable entrepreneurship.

The remainder of the paper proceeds as follows. Section 2 outlines the methodological approach. Section 3 presents and discusses the empirical results. Finally, Section 4 sets out the study's main conclusions and policy implications.

## **2. Literature review**

Prior literature has shown that entrepreneurship is regarded as a key channel to develop sustainable products and services and implement new projects that address many environmental and social concerns. The importance of entrepreneurs as a vehicle of economic and societal transformation is not new in the economic literature. [At least there are two main strands of literature dealing with this topic: sustainable entrepreneurship literature and Environmental Kuznets Curve literature.](#)

### ***2.1. Sustainable entrepreneurship literature***

Many authors, such as Schumpeter (1934, 1942), Drucker (1985), and Matos and Hall (2007), among others, have examined the link between entrepreneurship and resolution of global problems. For instance, Cohen and Winn (2007) show that several types of market imperfections contribute to environmental pollution. They are considered as sources of significant entrepreneurial opportunities to establish the foundations for an emerging model of sustainable entrepreneurship that slows the degradation and gradually improves ecosystems. Similarly, York and Venkataraman (2010) propose entrepreneurship as a solution to, rather than a cause of, environmental degradation. The authors develop a model that embraces the potential of entrepreneurship to supplement regulation, corporate social responsibility, and activism in resolving environmental problems. For Shepherd and Pratzelt (2011), entrepreneurial actions can reduce environmental pollution and deforestation, preserve the ecosystem, and improve freshwater supply and agricultural practices. As a result,

entrepreneurship could be a solution to numerous environmental and social problems (Wheeler et al., 2005; Senge et al., 2007; Hall et al., 2010)<sup>3</sup>.

Since the seminal contribution by Baumol (1990), it has become clear that “Shumpeterian innovative entrepreneurs” coexist with “defensive and necessity entrepreneurs”; the latter being those who enter a new business not because of market opportunities and innovative ideas, but merely because they need an income to survive. This kind of “survival-driven” self-employment is particularly diffused in the Developing Countries (Naudé, 2009), where poverty and lack of formal opportunities often push people into entrepreneurial activities ranging from street vending to traditional and personal services in most cases within the informal sector (see, e.g., Stam, 2011; Goedhuys and Sleuwaegen, 2010).

Survival entrepreneurs can cause turbulence and negatively affect economic growth (Quatraro and Vivarelli, 2014). Moreover, increasing survival entrepreneurship may be counterproductive both for environmental and economic point of view (Vivarelli, 2013). Innovative entrepreneurs are able to create jobs, transform the economy, and increase sustainability (Silvester, 2015). Innovation is a catalyst for change through which institutions, organizations, and countries can move the needle toward more sustainable products and services (Silvestre, 2015). Similarly, Almeida et al. (2013) and Lozano et al. (2013) suggest that society calls for more initiatives and investments from enterprises, educational institutions, and governments to adopt innovative solutions to solve current sustainability challenges. Thus, acknowledgment of entrepreneurship and innovation as solutions to, rather than causes of, social inequality and pollution, (York and Venkataraman, 2010) encourages the reconsideration of their important role in establishing sustainable economies. In spite of the efforts to generate unifying theories on the role that entrepreneurship and innovation play in achieving sustainable development, the ecological and the social embeddedness urge us to rethink our existing explanations and assumptions (Shepherd and Patzelt, 2011; Coenen et al., 2012; Munoz et al., 2013).

Opportunity entrepreneurship is viewed in this literature as a possible solution for environmental degradation and Climate Change. In fact, entrepreneurs are aware of the existence of an important potential market for product and services “environmental friendly”.

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<sup>3</sup> Several peer-reviewed journals such as *Harvard Business Review*, *Journal of Business Venturing*, and *Entrepreneurship: Theory and Practice* published special issues covering this topic in the last few years.

Proposing new services and products will capture “residual demand” in a first a step with higher margin. Previous works have shown how the green labeling was successful in developing these products in developed Countries and the trend is following in Developing Countries. Since then, a new generation of entrepreneurs, helped by new technologies, will try to capture such a “niche”. In some cases, entrepreneurs may also face strong regulation that induce them to use more sustainable methods of production. In this case, “opportunity entrepreneurs” will take this opportunity to increase their market share or to enter new markets. This was not possible before the change of the regulation.

While this first strand of the literature recommends strongly entrepreneurship as a source of sustainability and shows how it can works, the link with the macroeconomic context is very weak. Most of these works consider the “macroeconomic environment” as given and do not consider interactions between the entrepreneurship practices and the quality of institution for example. It is clear that such a hypothesis is very weak in a context like the African Continent.

## ***2.2. Environmental Kuznets Curve literature and entrepreneurship***

One of the most puzzling research questions is the Environmental Kuznets Curve. The EKC describes a relationship where in the early stage of economic development environmental degradation increases with per capita income, and after a certain level of per capita income, environmental quality increases with a rise in per capita income. Despite the large diffusion of EKC studies, there is no clear answer to this question. This literature has received many criticisms for incompleteness in terms of sustainability analysis.

Nowadays, a more sustainability-oriented EKC model appears to be a new strand of research that may connect new theoretical formulations with an additional specification of empirical results. For this reason, Tamazian et al. (2009) argue that EKC is captured not only by analyzing the relationship between GDP growth, environmental degradation, and energy use, but also by other important variables that affect environmental pollution; these should be included in the environmental function to avoid omitted variable bias in the econometric estimation. Accordingly, many researchers have introduced other significant determinants of environmental degradation that improve the representation of the EKC model, such as foreign trade (Omri, 2013; Al-mulali, 2015; Omri et al., 2015), human development (Costantini and Monni, 2008; Gürlük, 2009), and financial development (Shahbaz et al., 2013; Omri et al., 2015). Moreover, other researchers focus on the emerging entrepreneurship activity debates in

environmental economics. For example, York and Venkataraman (2010) consider entrepreneurship as a solution to, rather than a cause of, environmental degradation. Shepherd and Pratzelt (2011) argue that entrepreneurship can protect the ecosystem, improve environmental quality, reduce deforestation, improve agricultural practices, and increase freshwater supply. Accordingly, we introduce entrepreneurship as key determinant of sustainable development in the EKC model. One of our objectives is show the relevance of entrepreneurship activity (formal and informal) in the EKC model.

Considering the Environmental Kuznets Curve helps us to examine how microeconomic behavior change may impact the macroeconomic performances of a country. At the same time, the behavior of the actor may be sensitive to the level of development of a given economy. For example, as the level of development increases the awareness about environmental degradation is increased and this induce changes in the behavior of the consumers and “entrepreneurs”.

Our paper tries to link the two types of literature and to examine how the kind of entrepreneurship is sensitive to the macroeconomic variables in order to achieve sustainable goals.

### 3. Methodological approach

#### 3.1. Model development

The existing literature leads us to formulate the following EKC model:

$$P_{it} = \alpha_0 + \alpha_1 Y_{it} + \alpha_2 Y_{it}^2 + \alpha_3 E_{it} + \alpha_4 T_{it} + \alpha_5 F_{it} + \alpha_6 MHDI_{it} + \alpha_7 FE_{it} + \alpha_8 IE_{it} + \mu_{it} \quad (1)$$

where P, Y, Y<sup>2</sup>, E, T, F, MHDI, FE, and IE indicate environmental pollution, per capita GDP, squared per capital GDP, energy consumption, trade liberalization, financial development, modified human development index, formal entrepreneurship, and informal entrepreneurship, respectively. In this equation, we use a modified human development index (HDI) that does not contain GDP. Moreover, the absence of the income factor in the modified HDI is to avoid multicollinearity among per capita income and HDI variables. As a result, our models use MHDI as an indicator of human development.

Since our objective is to analyze the relationship between entrepreneurship activity and sustainability using a modified EKC, we follow the methodology of Costantini and Monni (2008) that consists in replacing the environmental pollution-related dependent

variable (P) by negative genuine saving (−GS) as an indicator of non-sustainability. We also replace per capita GDP in the standard EKC with a more capability-oriented measure (i.e., HDI) to incorporate innovation (Franceschini et al., 2016) and institutional quality<sup>4</sup> as important determinants of sustainable development (Costantini and Monni, 2008).

According to Costantini and Monni (2008), the GS index is expressed as follows:

$$GS = \dot{K} - (F_R - f_r)(R - g) - b(e - d) \quad (2)$$

where K, FR, fr, R, g, b, e, and d indicate economic capital formation, resource rental rate, marginal cost of extraction, resources extracted, natural growth rate of renewables, emissions, natural dissipation, and the marginal cost of abatement, respectively.

GS is based on the assumption of both the perfect and limit value of sustainability, where

- *Sustainability (+GS) → GS > 0*
- *Minimum level of sustainability → GS = 0*
- *Non-sustainability (-GS) → GS < 0*

The relationship between economic growth and environmental degradation given by Eq. 1 can be reformulated by using MEKC, introducing innovation and institutional quality as factors of sustainability, replacing the environmental pollution-related dependent variable (E) by −GS as an indicator of non-sustainability, and substituting per capita GDP with a more capability-oriented measure such as HDI. Considering that GS is computed in economic terms, the income dimension in the standard HDI could lead to multicollinearity and bias estimation. For this reason, MHDI is constructed as a simple average of life expectancy and the education index. Moreover, the absence of GDP in the MHDI mitigates the multicollinearity concern among GS and HDI.

Regarding the standard EKC model, incorporation of additional control variables allows us to examine the contribution of entrepreneurship, innovation, and institutional quality toward achieving sustainable development goals. Accordingly, our final models representing the standard EKC (Model 1) and MEKC (Model 2) are given, respectively, by the following two equations:

$$\begin{aligned} P_{it} &= \alpha_0 + \alpha_1 Y_{it} + \alpha_2 Y_{it}^2 + \alpha_3 E_{it} + \alpha_4 T_{it} + \alpha_5 F_{it} + \alpha_6 MHDI_{it} + \alpha_7 FE_{it} + \alpha_8 IE_{it} + \mu_{it} \\ -GS_{it} &= \beta_0 + \beta_1 MHDI_{it} + \beta_2 MHDI_{it}^2 + \beta_3 FE_{it} + \beta_4 IE_{it} + \beta_5 IN_{it} + \beta_6 RL_{it} + \beta_7 T_{it} + \varepsilon_{it} \end{aligned} \quad (3)$$

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<sup>4</sup> Defined by rule of law (RL).

(4)

where  $i$  and  $t$  denote the country and the time period, respectively.  $\alpha_0$  and  $\beta_0$  indicate the fixed country effects.  $\mu$  and  $\varepsilon$  are error terms.  $\alpha_j$  ( $j=1\dots 8$ ) are the elasticities of environmental pollution with respect to per capita GDP ( $Y$ ), squared GDP per capita ( $Y^2$ ), energy use ( $E$ ), foreign trade ( $T$ ), financial development ( $F$ ), modified MHDHI (MHDHI), formal entrepreneurship (FE), and informal entrepreneurship (IE), respectively. In Eq. 3, we use per capita  $CO_2$  emissions as a measure of environmental pollution ( $P$ )<sup>5</sup>. The parameters  $\beta_k$  ( $k=1\dots 7$ ) are the elasticities of  $-GS$  with respect to linear (MDHI) and non-linear (MDHI<sup>2</sup>) terms of the modified HDI, formal entrepreneurship (FE), informal entrepreneurship (IE), innovation (IN), rule of law (RL), and trade openness (T), respectively.

## 2.2. Data description

The present study uses annual data from 2001 to 2014<sup>6</sup> for 17 African countries, namely, Algeria, Angola, Botswana, Burkina Faso, Cameroon, Côte d'Ivoire, Egypt, Gabon, Ghana, Mozambique, Morocco, Nigeria, Senegal, South Africa, Togo, Tunisia, and Zambia. The data are from World Development Indicators, Global Entrepreneurship Monitor (GEM), United Nations Education Science and Culture Organization (UNESCO), and United States Patent and Trademark Office (USPTO) database. Our data include the following variables:

- *CO<sub>2</sub> emissions*:  $CO_2$  emissions are the release of carbon into the atmosphere. This indicator is used as a measure of environmental degradation. Data are in metric tons and collected from World Bank Indicators.
- *GS*: According to the World Bank (2010), “Genuine saving index (also known as adjusted net saving) is a sustainability indicator building on the concepts of green national accounts. Genuine saving index measures the true rate of savings in an economy after taking into account investments in human capital, depletion of natural resources and damage caused by pollution.” Costantini and Monni (2008) argue that the GS index “is the only available macroeconomic sustainability indicator calculated for a wide range of countries and for a consistent time series.”<sup>7</sup> Per capita GS is used as a measure of sustainability. Data are in constant U.S. dollars and collected from World Development Indicators.

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<sup>5</sup> The choice of  $CO_2$  emissions as the dependent variable in this study is driven mainly by data availability and so as to maximize observations.

<sup>6</sup> Selection of the period of study depends upon the availability of data on entrepreneurship.

<sup>7</sup> For more details about this index, see Hamilton and Clemens (1999).

- *Gross Domestic Product (GDP)*: GDP has since the 1930s been the most widely known measure of national growth worldwide (Lippman, 2009). The measure has been developed and become a standard benchmark used by policymakers and is widely discussed in the public sphere (Bleaney and Nishiyama, 2002). It tells us how much a country's production has increased (total value added of the economy). Data are in constant U.S. dollars and collected from World Bank Indicators.
- *Trade*: The trade openness index is an economic metric calculated as the ratio of a country's total trade (i/e, the sum of exports plus imports) to the country's GDP.
- *Energy*: Energy consumption refers to the consumption of primary energy, which refers to energy forms before transformation to other end-use fuels. Data are measured in metric tons of oil equivalent and collected from World Development Indicators.
- *Financial development*: Following Ang and McKibbin (2007), we use principal component analysis to choose the best measure of financial development between the three indicators of financial development identified in the existing literature, namely, total credit to private sector as share of GDP, board money as a share of GDP (M2), and liquid liabilities as a share of GDP (M3). The results of the principal components analysis are given in Table 1. They show that the first principal component is the total credit to the private sector as a percentage of GDP is the best measure of financial development. This variable is collected from World Bank Indicators.

**Table 1**

Results of the principal component analysis.

Component	Eigenvalue	Difference	Proportion	Cumulative
<i>Comp 1<sup>a</sup></i>	2.018	1.374	0.673	0.673
<i>Comp 2<sup>b</sup></i>	0.644	0.306	0.215	0.888
<i>Comp 3<sup>c</sup></i>	0.338	-	0.112	1.000

*Notes: a, b and c refer to the total credit to private sector as share of GDP, board money as share of GDP (M2), and liquid liabilities as share of GDP (M3), respectively.*

- *Innovation*: Several indicators are used to measure innovation activity, such as Global Innovation Index (e.g., Crespo and Crespo, 2016) and the number of patents registered at the USPTO<sup>8</sup> (e.g., Anokhin and Schulze, 2009; Hudson and Minea, 2013; Castellacci and Natera, 2015). Since our study needs a large time-series dataset that comprises both developed and developing countries, we use the number of patents per capita granted to residents of a given country each year as a proxy for innovation. This variable is collected from the USPTO.

<sup>8</sup> U.S. Patent and Trademark Office (2015).

- *Institutional quality*: Kaufman et al. (2003) argue that institutional quality could be described using political instability, rule of law, government effectiveness, regulatory framework, control of corruption, and property rights. Following Costantini and Monni (2008), we use rule of law (RL) as a proxy for institutional quality. The World Bank considers rule of law to be one important dimension of governance in the control of corruption.
- *HDI*: The human development index includes three dimensions of development: education, health, and income. An index is calculated for each of the three dimensions. HDI is calculated using a simple average of the three indices: education, life expectancy (a proxy for Health), and GDP (a proxy for the national income). To calculate these indices, we use World Development Indicators and UNESCO datasets. Table 2 provides the formulas of the indices.

**Table 2**

HDI calculation.

Dimension index = $\frac{\text{Actual value} - \text{Min value}}{\text{Max value} - \text{Min value}}$	-	-
Indicator	Max value	Min value
Life expectancy at birth (years)	75	40
Combined gross enrollment ratio (%)	100	0
Adult literacy rate (%)	100	0
GDP per capita (constant US\$)	7628,722	175.887
Education index calculation		
$Education\ index^a = (\ln(actual\ value) - \ln(min\ value)) / (\ln(max\ value) - \ln(min\ value))$		
GDP index calculation		
$GDP\ index = (\ln(actual\ value) - \ln(min\ value)) / (\ln(max\ value) - \ln(min\ value))$		
HDI calculation		
$HDI = ((1/3 * Education\ index) + (1/3 * Life\ expectancy\ index) + (1/3 * GDP\ index))$		

Notes: <sup>a</sup> Education is measured by (2/3 adult literacy rate + 1/3\*gross enrollment index). However, due to data availability, we only consider the combined gross enrollment ratio to calculate the education index.

We use an MHDI that does not contain GDP to measure only the average achievements in a country in two basic dimensions of human development (education index and life expectancy index). Moreover, excluding the income factor from the MHDI mitigates multicollinearity between per capita income and HDI. Data for education and life expectancy are collected from World Bank Indicators.

- *Formal entrepreneurship*: To measure formal entrepreneurship, we use the number of newly registered businesses per 1,000 working-age individuals aged between 15 and 64 years. This measure is provided by the World Bank and is designed to capture formal entrepreneurship. It provides well-established measures of formal

entrepreneurship that cover more than 103 countries for the period 2001–2014. As in Dau and Cazorra (2014), we use this measure of formal entrepreneurship:

$$\text{Form. entrep.} = \frac{\text{Number of new registered business}}{\text{Working age population}}$$

- *Informal entrepreneurship*: Given the lack of extensive and orderly data on unregistered businesses and difficulties in sourcing reliable data, we generate an informal entrepreneurship index using cross-country data from World Bank (WB; this index focuses on newly registered business) and from the GEM (GEM; this index includes registered and unregistered businesses per 1,000 working-age individuals). GEM data are given as the total number of businesses without separating them into formal and informal enterprises. This provides a well-founded measure of entrepreneurship that covers 103 countries from 2001–2014. Therefore, we measure informal entrepreneurship by subtracting formal entrepreneurship from total entrepreneurship. It is worth noting that both variables are based on recent and inclusive datasets (2014). Following Dau and Cazorra (2014), we use this measure of informal entrepreneurship:

$$\text{Infom. entrep.} = \frac{\text{Number of new registred and unregistred business}}{\text{Working age population}} - \frac{\text{Number of new registred business}}{\text{Working age population}}$$

Table 3 reports the results of Pearson correlation between all the panel series of variables. The correlation coefficients between variables suggest that the reported regression panel models are not seriously distorted by multicollinearity. This table shows that the CO<sub>2</sub> emissions variable is highly significantly correlated with per capita income, energy use, formal and informal entrepreneurship, innovation, and rule of law. The second dependent variable, namely, negative GS, correlates positively with per capita income, human development, formal and informal entrepreneurship, and correlates negatively with innovation and rule of law. All-in pairs reveal high-level and significant correlation. The pair-wise relationship can change when we integrate the variables in a panel based on multivariate regression analysis.

### 2.3. Panel unit root tests

Several economic variables are characterized by stochastic trends that might result in spurious inferences. A variable is considered as stationary if its autocovariances do not depend on time. Any variable that is not stationary has a unit root. The formal way to test the

stationarity of variables is the unit root tests (e.g., Maddala and Wu, 1999; Breitung, 2000; Levin et al., 2002; Im et al., 2003).

Table 4 reports the results of the several panel unit root tests. The Breitung unit root test contains individual linear trends and individual fixed-effects as regressors. The values given in Table 4 illustrate that the null hypothesis of a unit root cannot be rejected at the level of the variables, indicating that each time series is panel non-stationary. On the contrary, after application of these tests at the first difference level, the null hypothesis for each of the variables can be rejected at the 5% and 1% levels. All our series of variables are stationary at first difference, indicating that they are integrated at first order (I(1)) in each panel.

**Table 3**  
Pearson correlations.

	P	-GS	Y	T	F	E	MHDI	FE	IE	IN	RL
P	1.000										
-GS	0.620	1.000									
Y	0.694**	0.702**	1.000								
T	0.421	0.456	0.436	1.000							
F	0.179	0.533*	0.329	0.159	1.000						
E	0.673*	0.622	0.624**	0.412**	0.256	1.000					
MHDI	-0.352**	0.705**	0.168	0.239	0.417	0.426**	1.000				
FE	0.712*	0.782**	0.625**	0.387	0.669*	0.423	0.792**	1.000			
IE	0.794*	0.798*	0.714*	0.523	0.329	0.388	0.436	-0.796*	1.000		
IN	-0.788*	-0.773*	0.692**	0.519**	0.408	0.530	0.788*	0.699**	0.586**	1.000	
RL	-0.791*	-0.768*	0.368**	0.432	0.389**	0.589**	0.711*	0.780*	-0.703**	0.790*	1.000

Note: \* and \*\* indicate correlation significance at 1% and 5% levels, respectively.

**Table 4**  
Results of panel unit root tests.

Variables/methods	Breitung		Levin et al.		Im et al.	
	Level	$\Delta$	Level	$\Delta$	Level	$\Delta$
-GS	-0.683	-6.233*	-0.217	-8.210*	-0.179	-10.098*
Y	1.233	-8.817*	1.009	-11.023*	0.957	-15.552*
T	-1.128	-5.025*	0.072	-7.257*	0.355	-6.521**
F	-0.237	-7.009*	-0.836	-5.241*	-0.442	-5.553*
E	-0.389	-6.118*	-0.920	-8.019*	1.163	-9.114*
MHDI	-0.023	-4.520**	-0.055	-5.413*	0.122	-8.218*
FE	-0.489	-7.771*	0.283	-6.837*	-0.721	-10.301*
IE	-0.893	-8.025*	-0.624	-7.092*	-0.360	-8.530*
IN	-0.189	-5.396*	0.117	-6.142*	-0.248	-12.231*
RL	-0.026	-6.124**	-0.009	-5.220*	0.177	-8.473*

Notes:  $\Delta$  denotes first differences. Significance levels: \* (1%) and \*\* (5%).

#### 2.4. Panel cointegration test

Engle and Granger (1987) indicate that a linear combination of two or more non-stationary series of variables may be stationary and therefore are said to be cointegrated. These cointegrated series of variables may be interpreted as a long-run equilibrium

relationship between variables. According to Granger (1988), cointegration exists if two or more non-stationary variables have the same order of integration. To test the cointegration equations, Maddala and Wu (1999) recommend a Fisher cointegration test based on the multivariate framework of Johansen (1991) rather than using the Engle-Granger method, because the maximum likelihood procedure has significantly large and finite sample properties. To test the number of cointegration relationships, the Johansen (1991) method uses two ratio tests: (i) a trace test and (ii) a maximum eigenvalue test. Both can be applied to determine the number of cointegrating vectors present, although they do not always indicate the same number of cointegrating vectors. In applying the Johansen method, if we find different results between the two ratio tests, the result from the maximum eigenvalue test is preferred in this study due to the benefit of separate tests on each eigenvalue.

The results of the Fisher-type Johansen panel cointegration test are reported in Table 5. They indicate, for both models, that the assumption of cointegration tests allows for individual effects but no individual linear trends in vector autoregression. The null hypothesis of no cointegration is rejected at the 1% significance level. Furthermore, both the trace and the maximum eigenvalue statistics show strong support and evidence for cointegration relationships between variables in all models. Thus, we conclude the existence of a panel long-run equilibrium relationship between the variables under consideration in both models, meaning that they move together in the long-run.

**Table 5**  
Fisher-type Johansen panel cointegration test.

Models	Model 1 <sup>a</sup>		Model 2 <sup>b</sup>	
Number of cointegrating equations	Trace test	Maximum-eigen test	Trace test	Maximum-eigen test
None	496.520*	412.119*	388.210*	352.443*
At most 1	318.008*	284.773*	305.791*	296.224*
At most 2	277.304*	199.263*	194.937*	155.408*
At most 3	168.566*	91.907*	111.005*	87.083*
At most 4	103.370*	74.075*	89.294*	59.360*
At most 5	66.449	51.883	41.030	28.651
At most 6	50.506	33.714	37.563	23.007
At most 7	46.012	26.913	21.174	21.174
At most 8	16.550	16.550	-	-

Notes: Probability values for rejection of the null hypothesis of no cointegration are employed at 1% level (\*, p-value < 0.01) based on the MacKinnon et al. (1999) p-values.

<sup>a</sup> Model 1:  $P=f(Y, Y^2, E, T, F, MHDI, FE, IE)$ .

<sup>b</sup> Model 2:  $-GS=f(MHDI, MHDI^2, FE, IE, IN, RL, T)$ .

## 2.5. Testing panel-based multivariate regression models

Engle and Granger (1987) state that there are long-run equilibrium relationships between cointegrated non-stationary variables. Given this result, a panel-based error correction model (ECM) is applied to account for a long-run relationship using the two-step procedure of Engle and Granger.

Accordingly, panel-based ECMs can be constructed as follows:

$$\Delta \ln Y_{it} = \psi_{iY} + \sum_{j=1}^{n-1} \alpha_{ij} \Delta \ln X_{it-j} + \sum_{j=1}^{n-1} \beta_{1j} \Delta \ln Y_{it-j} + \lambda_i ECT_{t-j} + \varepsilon_{it} \quad (5)$$

where  $Y_{it}$  is the observation of the dependent variable for country  $i$  at time  $t$ .  $t$  represents 1, 2, 3, ...,  $n$  observations.  $\Delta$  is the difference operator.  $\psi$ ,  $\alpha$ , and  $\beta$  are the parameters of regressors.  $ECT_{t-1}$  is the error correction term obtained from the cointegrating vectors.  $\varepsilon$  is a stationary random error with a zero mean.  $j$  is the lag length. The panel-based ECM can be estimated using various types of panel data analytic models such as constant coefficient models and fixed- and random-effects models. The Hausman test is used to choose between fixed-effects and random-effects models. If this hypothesis is rejected, the estimation results given by the fixed-effects models are found to be more robust than random ones. The result of this test rejects the null hypothesis of random-effects models as more efficient and suitable for the three models. Probability values for rejection of the null hypothesis of no correlation are used at the 5% significance level. Accordingly, the results of fixed-effects models are more appropriate than random-effects models.

### 3. Regression results

Table 6 provides the results of panel-based ECM model using the fixed-effects estimator for Model 1. The reported coefficients are statistically significant at 1% or 5% levels. From the results of model 1, we find that 97.2% of the variation in CO<sub>2</sub> emissions of the African economies considered can be explained by the level of per capita GDP, energy use, trade openness, financial development, human development, and both formal and informal entrepreneurship. Therefore, we can see that informal and formal entrepreneurship have the highest contribution to environmental degradation in Africa, followed by financial development, energy consumption and per capita GDP. The magnitudes of 0.551 and 0.276 imply that a 1% rise in informal and formal entrepreneurship increases environmental degradation in African countries by 0.55% and 0.28%, respectively. These results mean that entrepreneurship activity in Africa positively contributes to environmental degradation and are consistent with Riti et al. (2015) for the Nigerian case. We can see that the contribution of

informal entrepreneurship to environmental degradation is much higher (0.551) compared to formal entrepreneurship (0.276). This result can be explained by the important size of the informal sector in the African context,<sup>9</sup> where more than one-third of small businesses are not legally registered. Most of African entrepreneurs seek to diminish costs by avoiding payment of taxes, social security contributions related to wages, retirement pensions, and other social benefits, and by avoiding legal labor market rules, such as safety and environmental standards, minimum legal age, minimum wages, and maximum working hours. Moreover, there is a significant cost to leaving the informal sector. Firms in the informal economy in most African countries, particularly small firms and the self-employed entities, may decide to continue to operate informally because the costs of formalization are higher than its benefits (Ihrig and Moe, 2001; Maloney, 2004).

Informal entrepreneurship has an important impact on environmental degradation. From the one hand, informal entrepreneurs are using less efficient technologies and methods of production than those in the formal sector. From the other hand, since they are in the informal sector they are not following the environmental standards and regulation, if any. Moreover, most of the informal entrepreneurs are survival entrepreneurs not seeking long-term considerations. As a result, they are not taking the consequences of their production process on the environment.

The second important finding from Table 6 is that the linear and non-linear coefficients of per capita GDP are positive and negative, respectively, providing evidence supporting the inverted U-shaped relationship between income level and environmental pollution. This result supports the EKC theory that pollution levels increase as countries develop, but begin to decrease as rising incomes pass beyond a threshold. These results are in line with Orubu and Omotor (2011) for 47 African countries, Shahbaz et al. (2013) for South Africa, and Mensah (2014) for 6 African countries. Regardless of the presence of EKC between economic growth and environmental degradation, since the coefficient of  $Y$  is much higher than the coefficient of  $Y^2$ , an increase in economic growth is expected to have a lower effect on the reduction of environmental degradation in the long-run. African Economies experienced a fast growth during the last decade (AfDB, 2014). While the impact of this

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<sup>9</sup>According to Schneider et al. (2010), the informal sector contributes to more than 50% of sub-Saharan Africa's GDP and 80% of the labor force. Ninety percent of rural workers have informal jobs in Africa and most employees are women and youth. The informal sector in Africa offers the most vulnerable populations such as the poorest, women, and youth opportunities to generate reasonable incomes and to improve their chances to

growth in the short term was negative in terms of environmental quality, the picture would be reversed in the long-term after they have reached a certain threshold. Economic growth is a necessary, but not sufficient, condition for sustainability.

Another important finding is that a 1% increase in total credit to the private sector leads to a 0.24% increase in per capita CO<sub>2</sub> emissions, meaning that financial development contributes to environmental degradation in African countries. For this reason, there is a need to further increase the level of financial development to achieve lower CO<sub>2</sub> emissions. Financial systems are weak. While in a first stage developing the financial sector can increase pollution, in a higher level of development financial sector may reduce pollution by motivating firms to adopt new and advanced environment-friendly technologies for production processes. This means that a sound and stable financial system can reduce environmental pollution through new advanced technologies. For this end, Stiglitz (2016), among others, advise to not follow the pattern of western financial systems (especially the US financial system). Africa can adopt more environment-friendly financial systems allowing for economic development and sustainability.

Moreover, consumption of energy exhibits a positive and statistically significant effect on carbon emissions at the 1% level. The coefficient magnitude of 0.227 implies that a 1% increase in energy use leads to an increase of 0.23% in per capita CO<sub>2</sub> emissions, indicating that an increase in the use of energy leads to increased environmental degradation. Similarly, we find that a higher level of trade openness is associated with a higher level of CO<sub>2</sub> emissions. This finding is consistent with Tiba and Omri (2015), where an increase in trade openness comes along with an increase in environmental pollution, particularly for less developed economies, due to delocalization of polluting industries, known as the pollution haven effect.

**Table 6**  
Fixed-effects results for model 1.

Independent variables	Model 1 <sup>a</sup>	
	'P' as dependent variable	
	<i>Coefficient</i>	<i>Probability</i>
Y	0.220 <sup>*</sup>	(0.007)
Y <sup>2</sup>	-0.123 <sup>**</sup>	(0.043)
E	0.227 <sup>*</sup>	(0.000)
T	0.061 <sup>**</sup>	(0.031)
F	0.239 <sup>*</sup>	(0.002)

send children to school and to access health services. However, workers involved in the informal economy are often without social protection, their incomes are not secure, and employment conditions are weak.

MHDI	0.040	(0.149)
FE	0.276*	(0.001)
IE	0.551*	(0.000)
Constant	1.525*	(0.000)
R-squared	0.972	
Adj. R-squared	0.964	
F-Statistic	2118.420	

Notes: P-values are reported in parentheses. Significance levels: \* (1%) and \*\* (5%).

<sup>a</sup> Model 1:  $P=f(Y, Y^2, E, T, F, MHDI, FE, IE)$ .

**Table 7**

Fixed-effects results for model 2 (without and with innovation and institutions variables).

Independent variables	Model 2 (“-GS as dependent variable)			
	Model 2a <sup>a</sup>		Model 2b <sup>b</sup>	
	<i>Coefficient</i>	<i>Probability</i>	<i>Coefficient</i>	<i>Probability</i>
MHDI	0.105**	(0.034)	0.161*	(0.002)
MHDI <sup>2</sup>	-0.098**	(0.011)	-0.158**	(0.013)
FE	0.281*	(0.000)	-0.204*	(0.000)
IE	0.424*	(0.000)	-0.066	(0.104)
T	0.107**	(0.046)	-0.170**	(0.037)
In	-	-	-0.449*	(0.000)
RL	-	-	-0.196*	(0.001)
Constant	0.866*	(0.000)	1.086*	(0.000)
R-squared	0.795		0.861	
Adj. R-squared	0.795		0.861	
F-Statistic	1497.913		3117.002	

Notes: P-values are reported in parentheses. Significance levels: \* (1%) and \*\* (5%).

<sup>a</sup> Model 2a:  $-GS=f(MHDI, MHDI^2, FE, IE, T)$ .

<sup>b</sup> Model 2b:  $-GS=f(MHDI, MHDI^2, FE, IE, IN, RL, T)$ .

Finally, we focus on the key research gap addressed in this work, i.e., understanding whether innovation and institutional quality could improve the relationship between entrepreneurial activity and sustainability in African. Table 7 reports the estimation results of Models 2a and 2b (MEKC). We find four important results. First, estimates of Model 2a give results similar to the traditional EKC, with lower R-squared values. It appears that informal entrepreneurship has the highest contribution to the –GS, followed by formal entrepreneurship and trade openness. The magnitudes of 0.281 and 0.424 indicate that a 1% increase in formal and informal entrepreneurship in African countries increases unsustainability by 0.28% and 0.42%, respectively. This result is in line with our previous findings. Informality and informal entrepreneurship are harming the environmental quality in Africa.

Second, from both models, we find that there is a quadratic relationship between –GS and human development in African countries, since the coefficient of MHDI is much higher

than the coefficient of squared MHDI; thus, an increase in human development is expected to have a lower effect on sustainability in the long-run. Thus, the current effort to reduce environmental degradation and to achieve sustainable development is not likely to be very effective given the level of the challenge.

Third, in estimating Model 2a, in which we include innovation and institutional quality variables, we find that innovation and institutions have negative and significant effects on negative GS at the 1% level. The magnitudes of  $-0.449$  and  $-0.196$  indicate that a 1% increase in innovation activity and institutional quality reduces negative GS by 0.45% and 0.2%, respectively. These results highlight the important roles played by innovation and institutions in achieving sustainability in Africa. Adopting new technologies and innovation improves the production methods and the efficiency of the African firms (less consumption of natural resources and less pollution). At the same time, better institutional quality implies an improvement in the management of economic and environmental resources and more effective laws in matter of environment and natural resources. Institutional quality means also more effective (environmental) law enforcement. While most of African countries have adopted environmental regulations, they still suffer from corruption and lack of law enforcement. Taking actions that improve institutional quality could reverse the situation. Our result is in line with those of Costantini and Monni (2008), where institutional quality constitutes a conditional variable to build a sustainable development path. Similarly, Silvestre (2015) argues that innovation constitutes a key pillar through which countries and firms can move toward more sustainable products and services.

Fourth, after the introduction of innovation and institutional quality in the MEKC, the signs of coefficients related to formal and informal entrepreneurship and trade openness become negative, indicating that all of them positively contribute to reaching a higher level of GS (but informal entrepreneurship is not statistically significant). This result is an opposite result to the traditional EKC reported in Model 1 and indicates that formal entrepreneurship accompanied by a high level of innovation and institutional quality positively contributes to achieving the sustainability goals in African countries. Thus, we can conclude that African governments have two simultaneous challenges to achieve sustainable entrepreneurship<sup>10</sup>: formalizing informal sector by putting incentive for informal entrepreneurs to become formal

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<sup>10</sup> Sustainable entrepreneurship could be described as innovation and entrepreneurship for sustainable development. It has been defined as “an innovative, market oriented and personality driven form of value

ones, and encouraging formal entrepreneurship to adopt more innovative solutions and more environment-friendly technologies in to produce more sustainable products and services. To deal with these challenges, governments should concentrate their efforts on informal entrepreneurship to help reduce its negative effect on the natural environment. Governments can encourage people to register their businesses, educate people to be oriented toward legal and regulated entrepreneurship, increase spending to stimulate markets, facilitate services to new firms to act in a formal way in the market. Governments also need to improve their systems through solid laws, well-defined property rights, transparency, and good policies for new entrepreneurs to enter the market. At the same time, there is a need to create incentives for young entrepreneurs to join the formal economy, especially by focusing on the burdens of the formal economy (e.g., fiscal policies). Building skills and making access to financial markets easier can set the “Gazelles free” and increase substantially the productivity of the informal economy (Arouri et al., 2014). In this context, De Soto (2003) argues that entrepreneurs must resort to operating in the informal sector because of unclear rules for creating a formal enterprise or because of bureaucratic barriers to legal property ownership and a lack of legal structures that recognize and encourage ownership of assets. Similarly, Autio and Fu (2015) declare that a one standard deviation increase in the quality of economic and political institutions could double the rates of formal entrepreneurship and halve the rates of informal entrepreneurship. In addition, the emergence of innovative businesses is vital for the move toward sustainability. For this reason, it is necessary to reinforce the innovation capacity of firms by investing in education and training programs, credit and patent protection, reinforcing cooperation between research centers and industries, and stimulating applied research for innovative products and services. Lozano et al. (2013) suggest that society requests more initiatives and investments from enterprises, educational institutions, and governments to adopt innovative solutions to resolve our present and future sustainability challenges.

#### **4. Conclusions**

Entrepreneurship has been cited as one of the solutions to meet future challenges such as climate change. Despite the fact that policy makers place great importance on entrepreneurship in moving ahead sustainable and inclusive development, the links between them remain unclear. Given this context, the purpose of our paper is to explore the conditions

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creation by environmentally or socially beneficial innovations and products exceeding the start-up phase of a

whereby entrepreneurship can simultaneously achieve economic growth and advance social and environmental objectives in Africa. More precisely, we attempt to better understand the central and critical roles of entrepreneurship, innovation, and institutions in moving toward a sustainable future in Africa. Using genuine saving (GS) as a measure of sustainability, we build an MEKC model to examine the interrelationship between innovation, institutional quality, entrepreneurship, and sustainable development in 17 African countries over the period 2001–2014.

Our empirical analyses provide interesting findings with regard to the sustainability process which have important policy implications.

First, we found that both forms of entrepreneurship activity in Africa (i.e., formal and informal) contribute to environmental degradation, where the contribution of informal entrepreneurship on environmental degradation is much higher compared to formal entrepreneurship. However, after taking into account innovation and institutional variables in the analysis, the effects of both forms of entrepreneurship on sustainability become positive, meaning that higher innovation and better quality of institutions constitute a driving force to achieve a higher level of entrepreneurship and sustainability.

Our findings have important policy implications. The improvement of governance and law enforcement in most of African countries are needed in order to achieve sustainable development. Several international development agencies are encouraging such reforms. Most of them are given loans conditional to implement “governance” reforms including “law enforcement”, “transparency”, “participation” and “accountability”. Setting the right institution can also improve the formality of the economy and thus improving the sustainability since formal entrepreneurs seems more able to move to sustainable development.

Second, we find that international trade could have positive effects on the considered countries. Our findings rely on the findings of Stiglitz (2000) who argue that trade and inward FDI (globalization) positively affect institutional quality, and globalization could be a cause of institutional improvement. Economies positively influenced by globalization are those that do well in developing their institutions in a democratic way and guarantee macroeconomic

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company” (Schaltegger and Wagner, 2007).

stability. Thus, the sustainability of such a process depends on how profits from the exploitation of existing resources are invested and how the lack of resources is addressed.

Our findings suggest free trade policies are a way of improving the efficiency of the economy, catching up with new technologies acquisition and improving the sustainability of the economy. Most of African countries are engaged in such process. However most of them are lacking economic diversification. They fear to import most of their goods and services. But new industries are starting in Africa and even the service economy is taking place.

Third, innovation and institutions constitute are necessary conditions for the emergence of sustainable entrepreneurship in Africa. Our paper relies on previous findings like Gerlach (2003) who addresses the necessity of approaching analysis of the role of sustainable entrepreneurs in implementing sustainable development from the perspective of innovation. The focus lies on innovation that improves sustainable development. Successful sustainable innovation is accomplished when entrepreneurial actors achieve competitive advantages, i.e., economic success by applying innovative environmental and social practices.

Our findings suggest promoting innovation and encouraging entrepreneurs to adopt new technology can improve the sustainability of the African economy. While the innovation measured in a narrow way (patents, etc...) suggest that Africa entrepreneurs are not very innovative, new evidence considering all the aspects of innovation show that African Firms are very innovative and benefitting from the technological revolution (especially Information and Communication Technologies) (Lorenz, 2014). Information and Communication Technologies are fostering “innovation” in Africa and causing a paradigm shift in several economic sectors. They are used in such way that promote sustainable development. For example, their use in Agriculture is “revolutionizing” this sector and causing improvement in the yields and the sustainability of the resources used.

Overall, it appears that while entrepreneurship is currently discussed as an important channel for fostering sustainability, there remains substantial uncertainty regarding the conditions needed to move toward sustainable products and services. This study constitutes a contribution in this direction; there remain substantial opportunities for further research in this emerging area. Among the several questions three appears as hot topics especially from the policy perspective: What characterizes sustainability-oriented entrepreneurship and how does it differ from traditional ones? What propels entrepreneurs to embrace a sustainable

orientation? What is the role of networks, partnerships, and other social and organizational ties in advancing sustainable entrepreneurship?

In addition to the insights and implications that this study proposes, there are several important limitations that should not go unmentioned. This study analyzes only the direct influences of innovation and institutional quality on the transition toward sustainable entrepreneurship. However, sustainable entrepreneurship is a complex process that could take place through several stages. For this reason, future work could extend this research framework by integrating moderating or mediating factors.

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