

## **Can financial inclusion offset the effects of pollution on life expectancy and mortality in sub-Saharan Africa?**

### **L'inclusion financière peut-elle compenser les effets de la pollution sur l'espérance de vie et la mortalité en Afrique subsaharienne ?**

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### Abstract

This paper examines the role of access to formal financial services in reducing the long-term effects of pollution on life expectancy and mortality in sub-Saharan Africa. The empirical evidence is based on the Generalized Method of Moments on data collected from 21 sub-Saharan African countries. The results show that, in the short term, financial inclusion through the multiplication of banking branches improves life expectancy and reduces mortality. In the long term, the effects of the pollution process in sub-Saharan Africa can be reduced and improved respectively on life expectancy and mortality through the promotion of financial inclusion defined by access to account creation facilities and the availability of banking branches.

**Keywords:** Financial inclusion; pollution; life expectancy; mortality; SSA

### Résumé

Cet article examine le rôle de l'accès aux services financiers formels dans la réduction des effets à long terme de la pollution sur l'espérance de vie et la mortalité en Afrique subsaharienne. Les preuves empiriques sont basées sur la Méthode Généralisée des Moments utilisant des données collectées auprès de 21 pays d'Afrique subsaharienne. Les résultats montrent que, à court terme, l'inclusion financière grâce à l'expansion des agences bancaires améliore l'espérance de vie et réduit la mortalité. À long terme, les effets de la pollution en Afrique subsaharienne peuvent être atténués et avoir des impacts positifs sur l'espérance de vie et la mortalité grâce à la promotion de l'inclusion financière, définie par l'accès aux services d'ouverture de compte et la disponibilité des agences bancaires.

**Mots-clés :** Inclusion financière ; pollution ; espérance de vie ; mortalité ; SSA.

## Introduction

Financial inclusion remains at the heart of international development debates, given its various beneficial effects on society. Existing literature supports this assertion at both macro and micro levels. Indeed, empirical studies have shown that inclusive finance ensures a country's economic and social development by reducing poverty and inequality and supporting economic growth (Galor and Zeira 1993, King and Levine 1993). The effect is also significant in terms of women's employability and integration into the economic fabric. Thus, financial inclusion enables the poor to invest in human and physical capital, facilitates their participation in the labor market and consequently contributes to social development.

Health problems are both a consequence and a cause of poverty. Maintaining good health is therefore a fundamental objective, inseparable from the quest for social and economic emancipation. The World Health Organization estimates that around 150 million people around the world face financial crisis every year as a result of health-related expenses, and that 100 million are pushed below the poverty line. Without tackling health issues, the impact of access to financial services will remain limited. Developing solutions that address health issues can be a winning bet for customers, society as a whole and financial service provider alike. For the latter, helping to keep customers and their families healthy makes good business sense. Yet, although there is strong demand for such solutions, only a handful of providers have attempted to meet the challenges associated with health.

Recent insights into development economics show that the ability of individuals to participate in income-generating activities is conditioned by their initial endowment of human resources. Access to financial services contributes to the improvement of social development indicators through improved health coupled with better education and expanded economic opportunities. Thus, the aim of this article is to analyze the effects of access to financial services (financial inclusion) on health (life expectancy at birth and mortality) in sub-Saharan Africa. In fact, this study is intended to complement the various results that have drawn a positive line as to the implications of financial inclusion on income and education.

The rest of this paper is organized as follows: section II presents a review of the theoretical and empirical literature. Analytical methods are presented in Section III. Section IV is devoted to results and discussion, and Section V concludes the paper.

### 1. Literature review

There are two types of relationship between financial inclusion and improved health. There is an indirect relationship through economic growth, and a direct relationship. The latter is not

very present in the economic literature. The United Nations (2012) noted that West, East, Central and Southern Africa would gain up to 22 years of additional life expectancy by reducing nutrition-related death and disease. Diseases spread because people struggle to meet their basic health needs, leading to death (Kpolovie, Oshodi and Iwuchukwu 2016). Most people tend to encounter health problems or have difficulty meeting their health-related needs, which probably shortens their lives, due to financial exclusion or lack of accessibility and use of financial services such as savings, pensions, credit, payment services and insurance. This is in line with Chamboko and Makuvaza's (2018) assertion that financial inclusion is a key device that facilitates life improvement and human development in society Kouladoum et al. (2022).

The provision of financial services to the poor would have the direct effect of reversing the trend observed in developing countries, and thus improve people's living conditions. At the microeconomic level, the financial system enables the creation of reliable, high-quality human capital. When it comes to investing in health and human capital in general, households need savings, loans and insurance. Access to these different financial services enables individuals to be a healthy, quality workforce, whose existence is an important condition for companies to invest more serenely.

In his 2005 study, Sachs showed that well-targeted direct aid can have an effect on poor populations by increasing agricultural productivity and thus reducing the incidence of disease. However, such a large-scale intervention will only have the effect of putting the poor first. It is therefore up to microfinance to enable them to move up the ladder. However, it should be noted that building a ladder requires a formal financing circuit. According to the World Bank's studies, the role of an efficient financial system is not only to carry out intermediary operations, but also and above all to stimulate growth by improving the productivity of businesses, one of the ways of genuinely reducing poverty or to accelerate economic growth in poor countries.

The links between poverty and health are clear, and improved health, well-being and quality of life are one of the main reasons. However, the causal links are complex, and whether individual income can improve individual health is unclear. In 2002, referring to a small number of studies investigating the benefits of health counseling, Abbot argued that benefits counseling located in primary care may have limited impact as a health intervention. On the contrary, it offers more potential for relieving psychological stress for service users and may

also make a small contribution to the physical health of children, individuals and the social capital of communities.

Adams et al. (2006), described the evaluations found as having limited scientific rigor and linked this to limited resources and skills. They concluded that there was "theoretical potential" for advice to improve health, but recommended more robust methodologies, including longer follow-up, as the health and social effects of increased financial resources could take years to become evident. They also advocated the use of randomized controlled trials.

Other reviews examining the effects of counseling on health have been identified. In 2002, Greasley and Small examined the same evaluations of the benefits of wellness counseling on participants' health and well-being as those included in the more recent review by Adams et al. (2006). Wiggan and Talbot in discussing selected studies, concluded that the literature indicated "significant improvements in clients' mental health as a result of successful intervention welfare entitlements and improvements in physical health, although these may be more limited". A review of social support services for people affected by cancer, focusing on: financial advice and support, highlights problems, bureaucracy and delays, but identifies less research that addresses the impacts of advice. Among the gaps identified, exist the impact of individual financial counseling approaches, understanding the impact of debt counseling on different population subgroups and the health outcomes of debt counseling. This review identified 16 key studies or journal articles that reported the health and social outcomes of financial inclusion interventions. We focused on studies published since the review conducted by Adams et al.

However, a small number have been included here as they contain information relevant to the present review, which concerns a financial inclusion activity, rather than focusing solely on advice provision in healthcare settings.

All the studies identified deal with the health effects of advice provision. Studies have generally focused on the provision of advice on social benefits, including maximizing income and work. However, Citizens Advice Bureaux (CABs) and many other advice services inform customers about a range of social, legal and welfare rights issues (including housing, employment, tax and debt). Several other studies highlight the wide range of issues addressed, and the fact that each customer can raise more than one problem. Interventions included: provision of advice located in primary care services. One project, covered in two separate articles, was located in a social services department; two were located on the advice provider's

premises; and one longitudinal study examined the impact of health advice, both in core CAB services and in outreach services in primary care. The remainder used a variety of delivery methods, including telephone advice and post-screening home visits.

Half the studies had no specified target group or did not target different groups of service users, others targeted people aged 60 or over, and individual studies focused on people with chronic illnesses, stroke patients and people with mental health problems. Although Abbott et al. identified the fact that increased income was modest but valuable, 28 other studies highlighted that increased income could help manage health, improve lifestyle habits and support relationships, for example with children.

A qualitative study revealed that the rehabilitation and speed of recovery of stroke patients was improved. Conversely, Moffatt and Scambler found that respondents' poor health was attributed to factors considered "immune to the effects of money", except insofar as more money gives greater ability to manage health conditions. The links between increased income and positive health changes are very important and complex. This raises questions about the importance of the nature of health. Condition is related to the point of intervention in the patient's journey.

For example, health may be more affected by increased income in acute healthcare or early diagnosis (such as stroke or cancer) compared to more chronic illnesses where long-term income or income inequality may be more important. Another consideration is that counseling and income maximization can help slow or prevent further deterioration in health. The links between poor mental health and other physical health problems, and the evidence of the positive effects of counselling on mental health from these studies, provide positive arguments for counselling. However, the impact on physical health may require much longer studies than have been possible to date. In the short term, however, "helping to alleviate the problems of those who are both deprived and very ill, even an imprecise intervention may be of value".

Campbell et al. (2007), suggested that external or other factors may have played a part in health stability, as opposed to increased financial income per se. In one study, "many participants spoke at length about the possibility of getting someone to take an interest, suggesting that the welfare consultation itself had a therapeutic effect". The importance of access to "talking therapies" was recognized in the design of the Health Plus project in Bradford. As well as providing counseling, this project mobilized two full-time equivalent counselors for brief intervention therapy for patients with mild mental illness. However, to

better meet the needs and demand of the service, the design was revised to include a larger multidisciplinary therapeutic team of 9 full-time posts with a team leader.

The study by Yunus, (2004). concludes that Grameen bank members have benefited in terms of a range of economic and social indicators including improved nutrition, better food intake, better consumption of clothing, better housing, lower infant mortality, higher adoption of family planning practices, better health, better access to education for children, empowerment of women's participation in social and political activities.

Popoola (2019) asserts that financial inclusion, measured by the number of depositors in commercial banks, positively determines improved longevity of life. Financial inclusion also helps strengthen an individual's ability to absorb impending health shocks (Love and Peria 2012; Popoola 2019). In a different way, financial inclusion, from the perspective of businesses and industries, is a driver of capital consumption or investment creation and commitment (CBN 2017), and this also applies to the individual household that produces and consumes economic goods and services in the economy. Investment in human capital is seen as a factor in improving health and extending life expectancy; knowledge and health are the main sources of human capital (Grossman 2005).

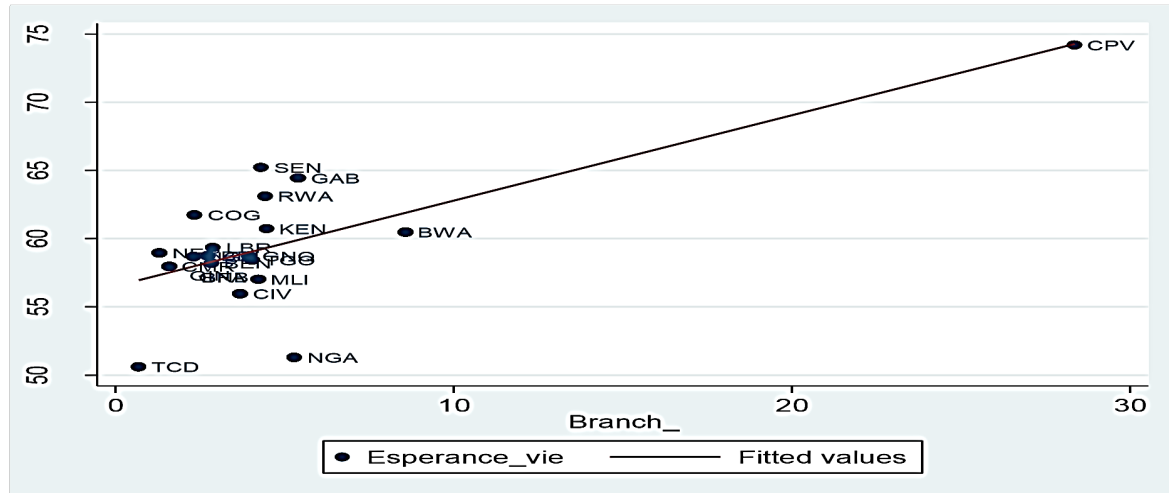
Lederle (2009) explores the effect of financial inclusion on the lives of disadvantaged people through an interview-based research strategy. The study highlighted the need to remove barriers to financial inclusion to have a significant impact on lives. Gyasi, Adam and Phillips (2019) explored the relationship between health-seeking behavior, financial inclusion and health related outcomes in Ghana using logistic regression and Poisson models. The research concluded that financial inclusion appears to contribute to a reduction in health-related problems. On the contrary, the study by Sahay et al. (2015) finds that, although Financial inclusion can achieve multiple macroeconomic objectives, but the multiple macroeconomic objectives or gains achieved reduce and fade as financial inclusion expands. The study therefore sent a strong signal of caution and moderation in the pursuit of financial inclusion policy to achieve macroeconomic objectives.

The study by Sahay et al. (2015) focuses on financial instability and economic growth as determined by financial inclusion, and therefore neglected the link between financial inclusion and life expectancy. However, Popoola's (2019) study has too narrow a scope since it only considers reach/access, without paying attention to the use dimension of financial inclusion. Furthermore, the study strictly limits the accessibility dimension indicator to the number of depositors with commercial banks only. The scarcity of research on this topic does



bank accounts per 1,000 adults remains considerable in Botwana (552 per 1,000) and Nigeria (618 per 1,000).

**Figure 2: Life Expectancy and Bank Branch in SSA**



Source: authors

Although financial inclusion has increased since the first World Bank questionnaire in 2011 (Global Findex Database 2011), financial inclusion indicators in Africa are all below the global average. Thirty-five (35%) of the African population has a bank account, compared with 61.5% worldwide. While 27.4% of the world's population has formal savings, only 15.4% of Africans deposit funds in a financial institution. Finally, 6.7% of the African population have taken out a loan with a financial institution in the last 12 months, compared with 10.7% worldwide.

The gap between Lesotho, last in the ranking, and Japan, first, is staggering: at birth, a child in Lesotho has a life expectancy that is almost 20 years lower. On average, they can expect to go to school for two years, compared with over twelve years for a child born in Japan. His parents live on less than \$1,000 a year - 68 times less than if his parents had lived in Norway. On the continent, the poorest countries are also the most unequal, and those where women have the fewest rights and choices.

East Africa and countries from Somalia to Kenya record the most impressive scores, while Central, Southern and West Africa lag behind, with healthy life expectancy of 54, 55 and 56 years respectively. In these countries, "healthy" life expectancy stood at 43 years in the 2000s. Today, it's 57 and 58. It's worth noting that, over the past decade, East Africa has experienced rapid growth. Between 2013 and 2017, it averaged 6.7%. That's double the figure for the entire continent over the same period. Unsurprisingly, countries in conflict, poor countries and countries that do not invest in health remain at the bottom of the league. These include the

Central African Republic, where the average life expectancy is just 53 years, Chad, Lesotho and Nigeria, whose situation has deteriorated as a result of social inequalities, security tensions and the brain drain.

However, the big surprise in this ranking is the position of Côte d'Ivoire, where the average life expectancy is only 57 years, as in Somalia and South Sudan, despite a GDP of 1.5 million CFA per person, according to the World Bank. While neighboring Senegal, with a GDP of just 1.1 million CFA per capita, has one of the highest life expectancies in Africa, with an average age of 68. A Senegalese person can expect to live ten years longer than an Ivorian.

### 3. Materials and methods

The econometric model of this work will be specified in accordance with the models of Lipfert (2014) and Fan et al. (2015) that have highlighted the impact of pollution on life expectancy and growth. Unlike the latter, this work will incorporate the dynamic effect of mortality and life expectancy variables likely to be influenced by pollution. Short-term estimation models will be specified as follows:

$$Expectancy_{it} = \beta_0 + \beta_1 Expectancy_{it-1} + \beta_2 CO2\_capita_{it} + \beta_3 gdp\_capita_{it} + \beta_4 Infl_{it} + \beta_5 eff\_gouv_{it} + \beta_6 FDI_{it} + \beta_7 Account_{it} + \beta_8 Branch_{it} + \lambda_{1,i} + \phi_{1,t} + \varepsilon_{1,it} \dots \dots \dots (1)$$

$$Mortality_{it} = \delta_0 + \delta_1 Mortality_{it-1} + \delta_2 CO2\_capita_{it} + \delta_3 gdp\_capita_{it} + \delta_4 Infl_{it} + \delta_5 eff\_gouv_{it} + \delta_6 FDI_{it} + \delta_7 Account_{it} + \delta_8 Branch_{it} + \lambda_{2,i} + \phi_{2,t} + \varepsilon_{2,it} \dots \dots \dots (2)$$

With Expectancy it the variable defining life expectancy at birth for country i in period t. Mortality<sub>it</sub> and Mortality<sub>it-1</sub> the crude death rate per 1000 people in period t and t-1 for country i in period t respectively. CO2<sub>capita</sub><sub>it</sub> and gdp<sub>capita</sub><sub>it</sub> are defined as the CO2 emission rate and per capita income of country i in period t. Infl<sub>it</sub> the inflation rate. Eff<sub>gouv</sub><sub>it</sub> the government efficiency index for each country at period t. FDI<sub>it</sub> the level of foreign direct investment considered. Account<sub>it</sub> and Branch<sub>it</sub>.  $\lambda_{1,i}$ ,  $\phi_{1,t}$  are respectively the error terms associated with the countries and the time dynamics. The specification of  $\varepsilon_{1,it}$  in the estimation model allows us to assume that there may be errors linked simultaneously to individuals and time.

In recent years, financial inclusion has been seen as a dynamic tool for achieving human development in developing countries (Li 2018; Djimoudjiel et al. 2022). It is also assumed to improve macroeconomic stability and inclusive economic growth (Liu et al. 2022). Theoretical developments support its positive contribution to human development and therefore health. In particular, this paper aims to highlight the role of inclusion in the

sustained (or long-term) effects of pollution on life expectancy and mortality. Long-term models of these effects, incorporating financial inclusion, can be specified as follows:

$$\begin{aligned} Expectancy_{it} = & \beta_0 + \beta_1 Expectancy_{it-1} + \beta_2 CO2\_capita_{it} + \beta_3 gdp\_capita_{it} + \beta_4 Infl_{it} \\ & + \beta_5 eff\_gouv_{it} + \beta_6 FDI_{it} + \beta_7 Account_{it} + \beta_8 Account_{it} * CO2\_sq \\ & + \beta_9 Branch_{it} + \beta_{10} Branch_{it} * CO2\_sq_{it} + \lambda_{1,i} + \phi_{1,t} + \varepsilon_{1,it} \dots \dots \dots (3) \end{aligned}$$

$$\begin{aligned} Mortality_{it} = & \delta_0 + \delta_1 Mortality_{it-1} + \delta_2 CO2\_capita_{it} + \delta_3 gdp\_capita_{it} + \delta_4 Infl_{it} \\ & + \delta_5 eff\_gouv_{it} + \delta_6 FDI_{it} + \delta_7 Account_{it} + \delta_8 Account_{it} * CO2\_sq \\ & + \delta_9 Branch_{it} + \delta_{10} Branch_{it} * CO2\_sq_{it} + \lambda_{2,i} + \phi_{2,t} + \varepsilon_{2,it} \dots \dots \dots (4) \end{aligned}$$

With CO2\_sqit the variable per capita CO2 squared. This variable measures the contribution of the sustained effects of pollution through carbon emissions on the variables explained. Cross tabulated with the variables branches (Branch \*CO2\_sqitit ) and accounts (Accountit \* CO2\_sqit ), it will reveal the role played by financial inclusion variables in the long-term effects of pollution on life expectancy and mortality rates.

We estimate the models using the system generalized method of moments (GMM). Estimating econometric models on financial inclusion, Immurana (2021), Djimoudjiel et al. (2022) and many other authors find this method to be the most suitable as it easily solves the problem of endogeneity and error autocorrelations due to the lagged variable. The main sources of endogeneity are measurement error, omitted variable bias and reverse causality. These problems arise for a variety of reasons, but they can be resolved using instrumental variables. Some diagnostic tests, such as the serial correlation test and Sargan's test statistic, are also used to demonstrate the validity of estimates.

### 3.1. Data and sources

The data used in this study comes from the World Development Indicators (WDI), the World Government Indicators (WGI) and the Global Financial Development Database (GFDD) for the period 2004-2022 on a sample of 21 sub-Saharan African countries.

**Table 1: Definition of variables and expected signs**

Variable	Description	Source	Expected Sign
<i>Expectancy</i>	Represents life expectancy at birth	WDI	
<i>Mortality</i>	Mortality rate	WDI	
<i>Account</i>	Bank Account for 1000 adults	GFDD	+
<i>Branch</i>	Bank Account for 1000 adults	GFDD	+
<i>Infl</i>	Inflation rate	WDI	-
<i>Gdp_capita</i>	Gross domestic product per capita	WDI	+
<i>FDI</i>	Foreign direct investment in %GDP	WDI	+
<i>Eff_gouv</i>	Index of perceived government effectiveness	WDI	+/-
<i>CO2_capita</i>	CO2 emission rate per capita	WDI	-

Source : Author's construction.

### 3.2. Descriptive statistics

Table 2 below presents the descriptive statistics for the study variables. It shows that average life expectancy at birth is 59.35 years. In terms of bank branches, there are an average of 4.5 commercial bank branches per 100,000 adults. In terms of accounts, on average 241 adults have a bank account per 1000 adults.

**Table 2: Descriptive statistics**

Variable	Obs	Mean	Std. Dev.	Min	Max
Gdp capita	410	2201.331	3033.574	128.538	19849.718
Infl	404	4.811	5.35	-8.975	34.695
FDI	410	4.112	9.303	-18.918	103.337
Expectancy	396	59.353	5.283	48.232	76.593
Mortality	396	9.762	2.519	4.868	16.982
Account	274	248.408	382.638	1.17	2173.18
Branch	331	4.569	5.906	.137	34.153
Eff gouv	397	-.807	.509	-1.807	.581
CO2_capita	418	.553711	1.2172	.011241	10.520

Source : Author's construction

With an average per capita income in the sample of countries estimated at \$2201, the level of CO2 pollution per individual averages 0.55 tones. The average government effectiveness index is -0.80, indicating poor institutional quality. On average, foreign direct investment accounts for 4% of GDP.

### 4. Results and discussion

In order to analyze the contribution of access to financial services in reversing the impact of pollution on life expectancy and mortality, three (3) cases will be highlighted. Firstly, confirmation of the effects of pollution (table 3) and financial inclusion (table 4) in the short and long term on life expectancy and mortality. Then, we highlight the short-term cross-effects between financial inclusion and pollution (table 5). Finally, the long-term implications of financial inclusion on its potential to mitigate the effects of pollution (table 6).

Table 3 below shows the results of the Effects of CO2 emissions on life expectancy (columns 1 and 2) and mortality (columns 3 and 4) in the short and long term. In the short term, the results show that CO2 emissions have a significantly positive influence on life expectancy (column 1), while the opposite effect occurs on mortality (column 3). The positive effect of pollution is contrary to the intuitions and results obtained by Arden and Dockey (2013) and Avram et al. (2015) for the case of China. The latter conclude that the effects of pollution on life expectancy depend on the rate of pollution itself. They thus find a negative effect of pollution for an emission density up to 100 $\mu\text{g}/\text{m}^3$ . What's more, despite these authors' specific

consideration of children aged 5, the short-term implications of pollution on mortality (column 3) overlap in a similar way with our results.

In the long term, the results show that maintained pollution has a negative and significant effect at the 1% and 5% thresholds on life expectancy (column 2) and mortality (column 4) respectively. Thus, a one-point increase in pollution leads to a reduction in life expectancy and mortality of the order of 0.018 points and 0.007 points respectively. Contrary to the a priori negative effect of pollution on short-term mortality (column 2), this can be explained by the already high mortality rates in the countries in the sample.

As for the other control variables, per capita income (gdp\_capita) and the inflation rate (Infl), the short- and long-term effects are negative and significant at the 5% and 10% thresholds respectively. The low upward variability of life expectancy in the countries in the sample is not significantly guaranteed by variations in income, let alone inflation. On the other hand, a certain variation in per capita income can intrinsically modulate downward the mortality rate in SSA.

**Table 3: Effects of CO2 emissions on life expectancy and mortality long-term**

	(1) Expectancy	(2) Expectancy	(3) Mortality	(4) Mortality
L.expectancy	.752*** (.011)	.754*** (.011)		
L.mortality			.831*** (.008)	.832*** (.007)
Co2_capita	.14*** (.013)	.276*** (.025)	-.049*** (.006)	.011 (.024)
Gdp_capita	-.0000333** (.000)	-.0000407** (.000)	.0000334*** (.000)	.0000289*** (.000)
Infl	-.021*** (.004)	-.017*** (.004)	.006*** (.002)	.005*** (.002)
Eff_gouv	.672*** (.187)	.898*** (.236)	.071 (.076)	.009 (.076)
CO2_sq		-.018*** (.002)		-.007** (.003)
Cons	15.685*** (.569)	15.645*** (.564)	1.386*** (.095)	1.343*** (.095)
Obs	371	371	371	371
Instruments	19	19	19	19
Countries	22	22	22	22
AR(1)	.007	.007	.011	.013
AR(2)	.829	.899	.966	.846
Sargan	.000	.000	.000	.000
Hansen	.143	.256	.161	.163

Standard errors are in parentheses \*\*\* p<.01, \*\* p<.05, \* p<.1

Source: Author's

The reciprocal is in fact true in the dynamic where the rise in per capita income responds positively to the inflationary process. It is well known that SSA countries have the lowest institutional quality indices (eff\_gouv) and the lowest average life expectancy in the world. Correlated with this state of affairs, an improvement in the value of the government efficiency index can lead to a drop in the mortality rate. If the current low value is maintained, this will primarily have the effect of not improving life expectancy. According to Hadipour et al (2023), institutional quality (measured by WGI indicators) has a more significant effect on mortality and life expectancy in high-income countries than in low-income countries. In fact, appreciable institutional quality makes it possible to develop and perpetuate the management of health systems, so as to perfect their implications.

Table 4 below shows the results of estimates of the effects of financial inclusion on life expectancy (columns 5 and 7) and mortality (columns 6 and 8) in SSA. Financial inclusion measured by the use of bank accounts (Account) per 1000 adults and the availability of bank branches (Branch).

In presence of these variables, the effects of pollution remain similar to those in the previous short-term cases. An increase in per capita income (gdp\_capita) has only a marginal impact on life expectancy and mortality rates in SSA. A 1% increase in per capita income will reduce the mortality rate, albeit only slightly (5.29e-06%), on the sole condition of access to bank accounts. However, the availability of bank branches is not a guarantee that the countries in the sample will promote a reduction in the mortality rate (column 8). This is shown by the positive and significant sign linking life expectancy to the Branch financial inclusion variable. Taking into account all the key variables in this section, the Account variable has a negative and significant effect at the 5% level on life expectancy (column 5). Having a bank account in a context where life expectancy at birth is low does not improve it. The high mortality rates explained by poverty conditions in SSA imply an opposite effect of financial inclusion on mortality. The results show a positive and significant effect at the 1% threshold of opening accounts on mortality (column 6). The conditions for improving the health system must be improved as a matter of priority, to enable financial inclusion processes to accompany the process. With this in mind, Ashraf et al (2010) and Dupas and Robinson (2013) conclude, for the Philippines and Kenya respectively, that the provision of an account via savings (deposits) improves human development.

**Table 4: Effects of inclusion on life expectancy and mortality**

	(5) Expectancy	(6) Mortality	(7) Expectancy	(8) Mortality
L.expectancy	.877*** (.014)		.813*** (.021)	
L.mortality		.931*** (.008)		.941*** (.007)
Co2_capita	.037*** (.007)	-.018*** (.002)	.011*** (.004)	-.033*** (.005)
gdp_capita	3.15e-06 (.000)	-5.29e-06** (.03)	-.0000308 *** (.000)	6.42e-06*** (.000)
Infl	-.01 (.008)	-.003 (.002)	-.005 (.004)	-.001 (.002)
Eff_gouv	.985*** (.067)	-.353*** (.024)	1.756*** (.142)	-.399*** (.05)
Account	-.0004932** (.045)	.001*** (.000)		
Branch			.105*** (.024)	.05*** (.004)
_cons	8.656*** (.827)	-.005 (.068)	12.434*** (1.13)	-.225** (.092)
Observations	258	258	310	310
Intruments	19	19	19	19
Countries	20	20	22	22
AR(1)	.049	.058	.051	.031
AR(2)	.353	.717	.483	.465
Sargan	.000	.000	.000	.000
Hansen	.165	.432	.171	.127

Standard errors are in parentheses \*\*\*  $p < .01$ , \*\*  $p < .05$ , \*  $p < .1$

Source: Author's

The variable banking Branch has a positive and significant impact on life expectancy at birth and mortality rates in SSA (columns 7 and 8). Thus, an increase in banking branches leads to an improvement in life expectancy and mortality, all other things being equal. These positive results corroborate those obtained by Djimoudjiel et al. (2022), who concluded that financial inclusion, based on the availability of banking branches in a country, improves human development.

Institutional quality, measured in this study by people's perception of the government's ability to formulate and implement policies (eff\_gouv), has a positive impact on human development in sub-Saharan Africa. Indeed, controlling for the effects of branches, deposits and bank accounts on mortality and life expectancy shows that in the presence of good institutional quality, the implications remain very conclusive, at most at the 1% significance level. Boettke and Subrick (2003) have shown, in the case of their work, that effective institutions are a

guarantee for the improvement of human conditions, notably health, education and income in economies, particularly developed ones. However, Djimoudjiel et al (2022) conclude that the condition for which the quality of institutions can favorably improve conditions lies in the promotion of access to bank accounts and the development of banking branches.

Table 5 below presents the results of short-term estimates of interactions between financial inclusion and pollution variables. The overall result is that, despite the controversial effects of financial inclusion and pollution in the previous cases, the promotion of financial inclusion variants has a significant impact on life expectancy and mortality rates in the expected directions. A 1% increase in bank branch availabilities improves life expectancy by 0.136% and at the 1% threshold (column 10). This effect prevails, even with persistent CO2 pollution of the environment. Through pollution, an increase in the number of banking branches can lead to a significant increase in life expectancy of 0.043% at the 1% threshold. While this improvement in banking branches reveals a controversial positive link on mortality (column 12), the dynamics in the presence of pollution yield conclusive effects. This shows that, through pollution, a 1% increase in banking branches in the countries in the sample can reduce the mortality rate in SSA by at least 0.025%.

**Table 5: Short-term cross-effects of inclusion with branches and bank accounts**

	(9) Expectancy	(10) Expectancy	(11) Mortality	(12) Mortality
L.expectancy	.878*** (.014)	.789*** (.023)		
L.mortality			.936*** (.011)	.954*** (.01)
Co2_capita	-.01 (.022)	-.25*** (.058)	.04*** (.008)	.111*** (.02)
Gdp_capita	4.48e-06 (.000)	-.000044*** (.000)	-6.49e-06*** (.000)	7.80e-06*** (.000)
Infl	-.008 (.009)	-.006 (.004)	-.003 (.002)	-.002 (.002)
Eff_gouv	.97*** (.07)	1.786*** (.193)	-.319*** (.033)	-.433*** (.055)
Account	-.001* (.000)		.001*** (.000)	
Account_CO2	.0001599 (.000)		-.000224*** (.000)	
Branch		.136*** (.049)		.07*** (.009)

Branch_CO2		.043*** (.012)		-.025*** (.003)
_cons	8.579*** (.787)	13.734*** (1.215)	-.082 (.141)	-.445*** (.134)
Obs	258	310	258	310
Instruments	19	19	19	19
Countries	20	22	20	22
Ar (1)	.05	.064	.059	.029
Ar (2)	.364	.761	.618	.483
Sargan	.000	.000	.000	.000
Hansen	.144	.135	.42	.326

Source: Author's

Standard errors are in parentheses \*\*\*  $p < .01$ , \*\*  $p < .05$ , \*  $p < .1$

As with previous findings, we expect to see a negative effect of access to bank accounts on mortality rates in SSA. Despite the contradictory effects obtained, the upward promotion of access to account opening facilities in the presence of CO2 pollution significantly reduces the mortality rate at the 1% threshold to 0.0002% (column 11).

Thus, improvements in life expectancy and mortality, all other things being equal, depend on the level of financial inclusion in the region. Nevertheless, the study also finds considerable evidence that population growth reduces life expectancy in sub-Saharan Africa. These findings are similar to those obtained by Popoola (2019), which asserts that financial inclusion, measured by the number of depositors in commercial banks, positively determines improved longevity of life. In other words, financial inclusion through branches and bank accounts cannot improve life expectancy and reduce deposit-constrained mortality.

**Table 6: Highlighting the long-term cross-effects of inclusion with branches and bank accounts**

	(13) Expectancy	(14) Mortality	(15) Expectancy	(16) Mortality
L.expectancy	.888*** (.016)		.803*** (.022)	
L.mortality		.927*** (.01)		.944*** (.01)
Co2_capita	-.011 (.022)	.021 (.015)	.029 (.045)	-.047*** (.018)
gdp_capita	.0000142*** (.000)	-.000016*** (.000)	-.00005*** (.000)	7.06e-06*** (.000)
Infl	-.003 (.009)	-.003 (.002)	-.0003083 (.005)	-.001 (.002)
eff_gouv	.996*** (.07)	-.358*** (.034)	1.768*** (.139)	-.407*** (.049)
Account	-.001**	.001***		

	(.000)	(.000)		
Account_CO2_sq	.0000209**	-.000016**		
	(.000)	(.000)		
Branch			.145***	.051***
			(.034)	(.007)
Branch_CO2_sq			-.001	.0003253
			(.001)	(.000)
_cons	7.99***	.019	12.855***	-.259**
	(.948)	(.093)	(1.16)	(.124)
Observations	258	258	310	310
Instruments	19	19	19	19
Countries	20	20	22	22
Chi <sup>2</sup>	87666.621	642452.67	244701.09	193085.51
Ar(1)	.054	.062	.064	.03
Ar(2)	.356	.637	.654	.471
Sargan	.000	.000	.000	.000
Hansen	.234	.361	.249	.889

*Standard errors are in parentheses \*\*\* p<.01, \*\* p<.05, \* p<.1*

Source: Author's

Environmental pollution is recognized a priori as a dynamic phenomenon whose effects are cumulative over time. In the short term, the implications may seem less conclusive from the point of view of certain authors. Indeed, it was the work of Grossman and Krueger (1995) that laid the foundations for work on the controversial relationship over time between growth and environmental degradation. Recent work, such as that by Chu (2021) and Pata (2021), still confirms the presence of controversial effects of economic variables in relation to environmental degradation.

Table 6 above presents the results of long-term estimates of the effects of CO2 pollution in a context of promoting financial inclusion. The results show that, in the long term, the negative and positive effects of pollution on life expectancy and mortality rates respectively can be reduced through financial inclusion in the form of access to bank account facilities (columns 13 and 14). However, this result remains valid subject to the level of per capita income. Thus, a 1% increase in per capita income and bank account creation reduces the long-term mortality rate by at least 0.00001% and 0.00016% respectively. These results are similar to those obtained by Adam and Phillips (2019), who showed that the inclusion of financial services appears to contribute to the reduction of health-related problems in Ghana. In the same trend, this improves long-term life expectancy by 0.000014% and 0.00020%. These results are significant for the 1% and 5% threshold effects of per capita income on the long-term impact of pollution modulated by access to bank accounts.

An analysis of the banking branch channel on the effect of pollution shows that, despite its contribution to improving living conditions (column 15), its contribution remains insignificant in the presence of an increasing rise in pollution. The presence of banking branches should normally be materialized by deposits or the creation of active bank accounts in order to modify the negative impacts of pollution.

Institutional quality as measured by government effectiveness shows the significant effects expected. Indeed, it appears that institutional quality improves life expectancy and reduces mortality in all contexts of long-term analyses, but particularly to the extent that banks increase the number of branches and guarantee access to bank accounts. Authors such as Outreville (1999), Ahmad et al. (2012) and Datta and Singh (2019) have carried out comparative analyses between developed and developing economies on the implications of financial inclusion on social, economic and human development variables respectively. For most of the effects obtained from the sample of SSA economies, subsequent results corroborate with some of the work, albeit subject to a strong consideration of institutional quality.

### **Conclusion and implications**

This paper aims to examine the contributory role of financial inclusion in the much-maligned implications of pollution on life expectancy and mortality in SSA. Two observations have prompted our interest in this issue. Firstly, the persistence of poverty in Africa. Secondly, the proliferation of financial inclusion indicators (microfinance institutions) in Africa. The paper contributed to the literature on the externalities of financial inclusion on life expectancy and mortality in the current context of the fight against environmental degradation. In order to achieve our objectives, theoretical and empirical developments were mobilized to econometrically study several variants of models estimated by the GMM method, on a sample of 21 sub-Saharan African countries over the period from 2004 to 2021. Overall, the results suggest controversial short-term implications of financial inclusion and pollution on life expectancy and mortality rates.

Furthermore, in line with the theoretical debates surrounding the effects of pollution on long term environmental degradation, financial inclusion through access to bank accounts helps to counterbalance the impacts. So, in the long term, if the level of pollution is maintained, the effects will be counterbalanced in a context where access to financial services and particularly the facilitation of access to financial services via the opening of bank accounts. Opening bank accounts and branches as a means of financial inclusion will significantly reduce mortality

rates and raise life expectancy levels in the sample of SSA countries. From all these facts, the impact of government efficiency remains consistent despite its low level in the countries considered. In both the short and long term, it positively modulates life expectancy and reduces mortality rates, contrary to the prior contribution of the inflation rate. All of the above points to the vital importance of strengthening financial inclusion policies aimed at improving access to financial services for all. Nevertheless, future studies could examine the control of the effects of pollution on well-being through financial digitization or ICT.

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