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Colonial and socio-economic history and HIV prevalence in sub-Saharan Africa: a multi-level model analysis

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Abstract

The present study shows that in sub-Saharan Africa, besides some individual characteristics (including gender, age, education, marital status, place of residence and the wealth index), the colonial and socio-economic history of an individual's living country significantly determines his/her current-day probability of being HIV positive. As a matter of fact, by using, essentially, the Demographic and Health Surveys (DHS) data of 16 African countries, we noticed that the risk of infection is higher among people living in Southern or Eastern Africa and lower in Western African countries. Those relatively high risk countries are generally landlocked and got their independence very early. They had relatively high fertility and HIV prevalence rate in the 80's and their legal system is derived from Common Law and Custom regulations. Compared to people in France former colonial countries, inhabitants of Belgium or both France and the United Kingdom former colonial countries have higher prevalence.

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1. Introduction

The Third Conference on Population and Development, held in Cairo in Egypt from 3 to 5 September 1994, recognized the absolute necessity to take action against HIV/AIDS which is a real threat to both health and economic development. This pandemic is one of points of highest priority for the late Millennium Development Goals (MDGs) and the Sustainable Development Goals (UN, 2014).

Since its inception in the 80's, 75.7 million people have been infected in the world, and 32.7 million died because of AIDS-related diseases (UNAIDS, 2020). In sub-Saharan Africa, 25.6 million people were HIV positive and 440 000 died in 2019. In other words, sub-Saharan Africa accounted for about 67% of people infected with HIV in 2019, while this part of the continent represented less than 10% of the world population.

The evolution of the disease is not the same in every part of sub-Saharan Africa. According to the fact sheet published by UNAIDS on World AIDS-Day in 2018, Southern and Eastern Africa represent the most affected zone with more than half of the worldwide infected population (59.44%). West and Central Africa account for only 11%. It is worth mentioning that East Africa and Central Africa were the most affected at the beginning of the epidemic (Amat-Roze, 1989).

In 1985, only five countries had registered HIV/AIDS cases in the continent: Rwanda, Kenya, Botswana, Angola and Central African Republic. In 1987, these statistics changed and several other countries had been affected by the disease (Congo, Uganda, Burundi, Malawi, Zambia, and Tanzania). During that year, Congo was the most affected, totaling 62.5 cases per 100000 inhabitants. Moreover, despite the high prevalence of some coastal countries such as Guinea-Bissau, Gambia, Côte d'Ivoire, and Ghana, their boarding countries (Guinea, Sierra Leone, Liberia, Togo, Benin and Nigeria) had low rates (Amat-Roze, 1989).

In 2016, United Nations established the top 10 nations concerned by the pandemic in Africa. These nations were Swaziland (26%), Botswana (23,4%), Lesotho (23,3%), South Africa (17,3%), Zimbabwe (14,9%), Namibia (13,4%), Zambia (12,5%), Mozambique (11,3%), Malawi (10%) and Uganda (7,2%) (UN, 2016). Nine out of ten of those countries are located in Southern Africa.

Given these statistics, there is no doubt that HIV/AIDS is still a reality that varies in size across countries. Despite endeavors to dispel doubts and suspicions, questions persist regarding its natural (or not) origin (Pepin, 2011). Indeed, many Africans are still believing that HIV/AIDS is a virus made to slow down population growth, and an intelligently organized contrivance to seize the resource of Africa. Contradicting Chersich and Rees (2008) and Kongnyuy et al. (2006), some people are arguing that sexual behavior alone cannot explain the origin and the diffusion of the disease (Brewer et al., 2003; Sawers and Stillwaggon, 2010). Others believe that the colonial legacy of African countries has contributed to the diffusion of the pandemic (Anderson, 2018). Bertocchi and Dimico (2019) found that the origin is historically more distant and could be related to transatlantic slave trade. In other words, the debate still remains complex and messy (Giles-Vernick et al., 2013), and it is therefore necessary to continue exploring the possible historical factors determining the prevalence of HIV. Basically, the issues raised in this paper are the following: does the colonial history have an impact on the current-day prevalence of HIV in sub-Saharan Africa? What are the historical post-colonial and socio economic characteristics of the sub-Saharan African countries where HIV is prevalent? What is the individual and national profile of people living with HIV?

Using a multi-level model and data from the Demographic and Health Surveys (DHS) of 16 countries across sub-Saharan Africa, this study first revealed that the current risk of infection for an individual depends on his individual characteristics such as the residential environment (urban or rural), the economic well-being of the household where the individual lives, the age, the gender, the educational level and the marital status. This risk also varies with the national characteristics of the individual's country of residence, such as the year of independence, the colonizing country, the fertility rate in 1980, the prevalence of HIV in 1980, whether the country is landlocked or not, etc. On the other hand, the political (Democratic or non-democratic) regime does not affect the risk of being HIV positive, unlike the legal system (Common Law, Civil Law or customary) which does.

In addition to the econometric approach, the contribution of this paper is twofold. First, most of recent papers studying the relationship between history and HIV in Africa (by considering more than one country in the continent) have focused on female HIV prevalence. Here, we consider a population consisting of both men and women. Second, besides the political history, we also consider the economic history. Here, the period of history also includes the years of the emergence of the disease (1980's). Specifically, in this paper, history consists of three periods: the colonial times, the years of independence and the years of the emergence of HIV/AIDS.

The rest of the paper is organized as follows. We first present data and methods of analysis. Then, we present the findings, and end with some discussion and concluding remarks.

2. Data

The data used in our work are mainly from the Demographic and Health Surveys (DHS 5 or DHS 6) of 16 African countries over the period 2009-2012 as shown in Table 1.

Table 1: The countries involved in the study, their geographical location and the year of the DHS.

Countries	Location	DHS
Burkina Faso	West Africa	2010
Burundi	East Africa	2010
Cameroon	Central Africa	2011
Congo	Central Africa	2009
Côte d'Ivoire	West Africa	2011-2012
Ethiopia	East Africa	2011
Gabon	Central Africa	2012
Guinea	West Africa	2012
Lesotho	South Africa	2009
Malawi	East Africa	2010
Niger	West Africa	2012
Rwanda	East Africa	2010
Senegal	West Africa	2010-2011
Tanzania	East Africa	2010
Uganda	East Africa	2011
Zimbabwe	South Africa	2010-2011

Source: Produced by the authors.

These data were downloaded from the DHS Program website. Although this site provides DHS data for all countries, we faced the problem of data availability. Indeed, it is important to have data of the same year or approximatively, but, unfortunately the year of the DHS largely varies

with the country. So, we could not work with all the 48 countries. The years for which data were available for most of the countries were 2009; 2010; 2011 and 2012, with the year 2010 prevailing. Hence, we considered 2010, corresponding to DHS 5 or DHS 6 for the involved countries. We also cared about the representativeness of the four major regions of sub-Saharan Africa (West, East, Center and South).

In each country, DHS are supervised by the national institutes of statistics with the support of some international institutions such as USAID, WHO, UNICEF, UNFPA, etc. DHS are surveys on representative households at the national level. They provide data for a wide range of monitoring and impact evaluation indicators in the domains of population, health and nutrition. They provide information on topics such as anemia, child health, domestic violence, education, family planning, fertility and fecundity, gender, HIV (knowledge, attitudes and behaviours), HIV prevalence, characteristics of households and respondents, mother health, nutrition, etc. The surveys use different types of questionnaire: Household questionnaire, individual questionnaire for males, and individual questionnaire for females.

In addition to data from DHS, we have gathered, through various sources (World Bank, States' websites, documents or handbooks of history, etc.), historical and economic data on countries (colonizing country, year of independence, gross domestic product (GDP) per capita in 1980, legal system, etc.). Finally, the approach to build the database is as follows: downloading the databases "HIV", "HOUSEHOLD" and "HOUSEHOLD MEMBERS" on the website of the DHS program, considering countries for which data for 2010 or surrounding years (2009-2012) are available, collecting historical and economic information on these countries in order to find an individual-level database for each country, and merging all databases. It is important to mention that our study focused on people aged between 15 and 49. The different variables in this study are presented in Table 2.

Table 2: Variables and occurrences.

Variables	Occurrences
Individual characteristics	
HIV status	0=negative, 1=positive
Type of residential environment	0=rural, 1=urban
Wealth index	0=very poor, 1= poor, 2=middle , 3=rich, 4-very rich
Gender	1=male, 2 =female
Age	0= [15-24[, 1= [25-34[, 2= [35-44, 3= [45-49[
Education	0=no education, 1=primary, 2=secondary, 3=higher
Marital status	0=never married, 1= married, 2= widowed, 3= divorced
National characteristics	
Location	1=West Africa , 2=East Africa, 3=Central Africa, 4=South Africa
Year of independance	
HIV Prevalence in 1980 (%)	
GDP per capita in 1980 (constant 2010)	
Fertility rate in 1980	

Variables	Occurrences
Country (indicator variable)	
Colonizing country	1=France, 2=Belgium, 3=United Kingdom, 4=France, United Kingdom, 5=None
Landlocked territory	0=no; 1=yes
Political system	1= Imperfect Democracy , 2=hybrid regime, 3= Authoritarian Regime
Legal system	1=Civil-law and Customary, 2=Common Law and Customary, 3=Common Law, Civil-law and Customary

Source: Produced by the authors.

3. Methods

3.1. Choice of the model

To conduct this study, we estimated a multi-level model. Indeed, statistical units are individuals while some variables are observed at the national level. A simple logit model cannot provide unbiased estimators. Moreover, the calculation of the variance of these estimators can be biased. To see if statistically the country influences HIV status, and therefore to justify the use of the multi-level model, an analysis of the variance (ANOVA) on the dependent variable according to the country could be made. But here, given the binary nature of the dependent variable, an analysis of variance is not suitable. We have therefore operated a binary logistic regression by including among the explanatory variables the dummy of the countries. The results are recorded in the table below.

Table 3: Logit model estimates showing the effect of the country variable on HIV/AIDS status.

Status	**Coefficients**	**Std. Err.**	**z**	**P-value**	**Interval of confidence**	
Covariates			**Significant**			
Countries						
Burundi	0.5431514	0.1147757	4.73	0.000	0.3181951	7681077
Cameroon	1.311879	0.0932438	14.07	0.000	1.129125	1.494633
Congo	0.8332661	0.1012614	8.23	0.000	0.6347974	1.031735
Côte d'Ivoire	1.215177	0.0997552	12.18	0.000	1.019661	1.4110694
Ethiopia	0.5558401	0.0913735	6.08	0.000	0.3767515	0.7349288
Gabon	1.165176	0.0998522	11.67	0.000	0.969469	1.360882
Guinea	0.605876	0.1150991	5.26	0.000	0.3802859	0.8314662
Lesotho	3.235872	0.0897611	36.04	0.000	3.059885	3.411859
Niger	-0.7516125	0.1727732	-4.35	0.000	-1.0902242	-0.4129832
Rwanda	0.9936468	0.980124	10.14	0.000	0.801546	1.185748
Senegal	-0.1376802	0.135174	-1.02	0.000	-0.4026163	0.1272559
Tanzania	1.30254	0.0905995	14.38	0.000	1.124968	1.480112
Uganda	1.780284	0.0879929	20.23	0.000	1.607821	1.952747
Zimbabwe	2.742792	0.0879282	31.19	0.000	2.570456	2.915128
constante	-6.911876	0.095364	-72.48	0.000	-7.098786	-6.724966

Source: Produced by the authors.

With a simple logit including individual characteristics, we find that the country indicator variable has a significant effect on HIV status. In other words, the country of residence explains some of the information contained in the HIV serological status of an individual. This justifies the use of the multi-level model.

3.2.Multi-level model

Multi-level models or hierarchical models (multi-level logistic regression) are designed to easily and accurately analyze multi-level structured data, like in Magadi and Desta (2011) and Adetokunboh and Are (2020). Our model is of two levels: the first level which corresponds to the characteristics of individuals (age, gender, educational level, wealth index of the household, marital status and type of residence environment), and the second level corresponding to the characteristics of the country (colonizing country, year of independence, landlocked territory, category of country, GDP per capita, fertility rate, etc.). The model to consider is as follows:

$$y_{ij} = \beta_0 + x_{ij}\beta + z_j\gamma + \alpha_j + \varepsilon_{ij} \qquad (1)$$

$$j=1,\ldots,J \qquad i=1,\ldots..,n_j$$

where $\varepsilon_{ij} \sim N(0, \sigma^2_\varepsilon)$ et $\alpha_j \sim N(0, \sigma^2_\alpha)$.

The double subscript **ij** illustrates the two-level structure of the model. Subscript **i** refers to the individual (individual characteristics) while subscript **j** refers to the group (national characteristics). The variable of interest y_{ij} refers to the HIV status of individual **i** of group (country) **j,** x_{ij} corresponds to the first level covariates: age, gender, type of the environment of residence, etc. Concerning z_j, it represents the second level covariates, i.e., the geographical location of the country, whether or not the country is landlocked, the year of independence, etc. β_0, β and γ are parameters or coefficients associated with the corresponding variables. $\alpha_j + \varepsilon_{ij}$ are the unobserved terms (Givord & Guillerm, 2016). For multi-level models, in addition to the significance of the coefficients of the explanatory variables, the significance of intra-group variance must also be tested. With regard to the coefficients, the classical approach of the Student test is used. For intra-group variance, the LR test (likelihood ratio) is used.

The diagnosis of the model is to identify which of the fixed effects model and the random effects model is the most suitable. The Mundlak test is used for this purpose. This consists in estimating the following model:

$$y_{ij} = \beta_0 + x_{ij}\beta + z_{ij}\gamma + \dot{x}_{.j}\,\theta + u_j + \varepsilon_{ij}, \qquad (2)$$

$$\text{where } u_j \sim N(0, \sigma^2_u)$$

$\dot{x}_{.j}$ is the mean of individual characteristics in country **j**. If θ is not significantly different from zero, then the random effect model is the most suitable. In this work, the implementation of the Mundlak test has brought to the choice of the random effect model. Ethiopia is a special country because it has not been colonized. The review of the country's history allowed us to analyze the outcome of the various wars of domination that the country experienced and to consider the year 1896 as the year of independence of Ethiopia. Given this peculiarity of this country, and for the sake of robustness of the results, we estimated two models, one of which including Ethiopia and the other excluding it. The interpretation tools used to present the results are coefficients and odds-ratios.

4. Results

As mentioned, we first estimated a model that excludes Ethiopia. Table 4 presents the results.

Table 4: Estimates from the multi-level model with random effects (without Ethiopia).

Independent variables	Coefficients	Odds-Ratios	P >|z|
Type of environment of residence (Ref= Rural)			
Urban	0.410 (0.033)	1.506	0.000
Wealth index (Ref= very poor)			
Poor	0.134 (0.038)	1.143	0.001
Middle	0.135 (0.039)	1.144	0.001
Rich	0.149 (0.041)	1.160	0.000
Very rich	0.154 (0.048)	1.167	0.001
Gender (Ref=Male)			
Female	0.329 (0.025)	1.390	0.000
Education (Ref=No education)			
Primary	0.292 (0.040)	1.338	0.000
Secondary	0.191 (0.045)	1.210	0.000
Higher	-0.222 (0.076)	0.801	0.004
Age (Ref= [15-24])			
[25-34]	1.071 (0.037)	2.920	0.000
[35-44]	1.281 (0.040)	3.601	0.000
[45-49]	1.087 (0,051)	2.964	0.000
Marital status (Ref= Never married)			
Married	0.261 (0,037)	1.298	0.000
Widowed	1.587 (0.058)	4.892	0.000
Divorced	1.082 (0,050)	2.951	0.000
Political system (Ref=Imperfect democracy)			
Hybrid regime	0.190 (0.155)	1.209	0.222
Authoritarian regime	0.115 (0.121)	1.121	0.344
Country location (Ref=West)			
East	0.355 (0.151)	1.425	0.019
Central	0.215 (0.147)	1.240	0.146
South	6.225 (0.494)	505.561	0.000
Colonizing country (Ref= France)			
Belgium	1.270 (0.146)	3.559	0.000
United Kingdom	0.243 (0.195)	1.275	0.212
France and United Kingdom	1.108 (0.102)	3.029	0.000
Year of Independence	-0.351 (0,020)	0.703	0.000
Prevalence of HIV in 1980	0.268 (0.019)	1.308	0.000
GDP per capita in 1980	0.0001 (9.36e-06)	1.0001	0.000
Fertility rate in 1980	0.245 (0.114)	1.278	0.031

Littoral (Ref=Not landlocked)			
Landlocked	0.822 (0,092)	2.276	0.000
Constant	679.519 (39.313)	1.3e+295	0.000
Log-likelihood = -28089.731			
Number of observations: 165426		Observation per group	
Number of groups: 14		Min	6741
Wald chi2 (28) = 10201.71		Average	11816.1
Prob chi2 = 0.000		Max	19680
LR test for rho=0 : P-value=1.000			

Source: Produced by the authors, *standard errors in (.).*

The analysis of Table 4 shows that the individual characteristics influencing the risk of HIV/AIDS are the residential environment (rural people are less at risk), gender (women are more vulnerable to the disease than men), education level (when people move from the "no education level" to a higher education level, their HIV risk increases, except for the transition to the university level where the risk decreases), economic welfare index or wealth index (the poorest are less vulnerable), age (the 35-44 years old are the most vulnerable, as in Adetokunboh and Are, 2020), and the marital status (widows and widowers are most vulnerable and singles are the least concerned). As for the national characteristics (details of which are provided below), the country's geographical location in Africa, the colonizing country, the year of independence, the prevalence of HIV in 1980, the fertility rate in 1980, the colonizing country, whether or not the country is landlocked are variables that are significantly associated with the individual's HIV/AIDS status. However, the level of economic growth in 1980 has no significant impact (or the size of the effect is very low).

Geographical location: Our findings reveal that the category "central" is not significant. Compared to individuals whose country is located in West Africa, individuals whose country is located in Eastern or Southern Africa are more likely to be HIV positive. More specifically, individuals from a country located in East Africa and Southern Africa run respectively 1.42 times and 505.6 times the risk of HIV infection than those from West African countries.

Year of independence: It appears from the estimates that the earlier the independence of the country of residence, the higher the risk for an individual of that country to be HIV positive. Specifically, every individual runs 1.42 times the risk of being HIV positive than those from a country that gained independence one year later than his country.

1980 HIV prevalence rate: The HIV prevalence of a country in 1980 impacts on the current risk of HIV infection for an individual of that country. More precisely, when the prevalence rate in 1980 increases by one point, the risk of being HIV positive is multiplied by 1.31. This could surely mean that the disparities between countries at the beginning of the epidemic have not changed completely, three decades later (Hanson and Hanson, 2008), despite initiatives from donors to reduce the prevalence of the disease (Gaibulloev and Sandler, 2012).

Fertility rate in 1980: The fertility rate of a country in 1980 impacts on the risk for an individual of that country to be HIV positive. Specifically, individuals from a country with a high fertility rate in 1980 are at a relatively high risk of being HIV positive today. Precisely, an increase in the fertility rate in 1980 by a point multiplied by 1.27 the risk of being HIV positive.

Landlocked country: The estimates show that direct access to sea impacts on HIV status. Specifically, compared to individuals from non-landlocked countries, individuals living in a landlocked country run 2.27 times the risk of being HIV positive.

The colonizing country: Compared to individuals whose country was colonized by France, individuals whose country was colonized by Belgium or both France and the United Kingdom are more likely to be HIV positive (3.56 and 3.02 times respectively higher). Robinson (2011) found similar result.

We have tried to understand the effect of the colonizing country on HIV/AIDS status today. Probably, the colonial legacy explains this fact. The review of the literature led us to study the contribution of the legal system. Indeed, the legal system denotes the institutions and their functioning allowing the enforcement of rules and principles governing the nation (David et al., 2016). From this definition, it can be clearly understood that the legal system in place in a former colony may depend on the colonizing country. For example, it is reported that Common Law is applied in many former colonies of the British Empire (David et al, 2016). In our data, the joint distribution of the legal system and the colonizing country shows that former colonies mostly practice the legal system of their colonizing country, besides the customary (traditional) rule system.

Therefore, we estimated the model by replacing the variable that captures the colonizing country with that of the legal system (see Appendix 1). It can be seen that individuals living in a Civil-Common-Law and customary rule country run 2.14 times the risk of being HIV positive than individuals in Civil-law system.

Remark. The introduction of Ethiopia in the model has completely changed the results. While individual characteristics continue to have a significant effect, none of the National variables now have an effect (except for the geographical location), even when we exclude the variable capturing the year of independence. This contradicts our results in Table 3. Ethiopia is therefore a somewhat atypical country and we have only retained the model without Ethiopia (see Appendix 2).

5. Conclusion and discussions

Besides individual characteristics such as age, gender, economic well-being, marital status, educational level and the residential environment, this study showed that the risk of being HIV positive in sub-Saharan Africa varies according to the region of the continent we consider. Indeed, countries in Eastern and Southern Africa are the most affected. This confirms UNAIDS statistics. Furthermore, the colonizing country is also decisive. Compared to an individual from a country colonized by France, an individual from a country colonized by the United Kingdom is 3.02 times more likely to be HIV positive. A closer analysis reveals that this could be due to the legacy of the metropolitan colonial legal system. Indeed, individuals living in a country under Common Law and customary rule are 1.73 times more likely to be HIV positive than individuals living in a civil-law and customary rule country or otherwise. This result is in line with Anderson (2018) who has shown that women in Common Law are more affected by the epidemic than those of the civil-law country. Similarly, individuals belonging to a country that did not obtain independence quickly had a lower probability of HIV/AIDS occurrence than those from a country having obtained independence earlier. Why does independence determine today HIV prevalence? It is delicate to give an explanation. One hypothesis could be that these countries have seen their health system deteriorate more quickly when the colonizer left. One might also think that access to independence has led to a certain licentiousness that the inhabitants have confused with freedom. Our results also suggest that countries with high rates

of HIV at the beginning of the epidemic are still those in which the virus is prevalent up today. This suggests that people are not yet sensitized enough, given the fact that the preventive measures taken to curb the disease since its emergence were mean to entail a decrease in its incidence (Temah, 2009). Finally, it could be noted that when GDP per capita in 1980 is high in one country, the risk of HIV/AIDS among its inhabitants increases (but very lowly). This is in line with Couderc N., Ventelou, B. (2005). Indeed, economic growth promotes mobility, attracts foreigners and fosters inter-human encounters (Magrama, 2008; Over and Piot, 1993; Pathé, 1991).

Regarding individual characteristics, we have concluded that the risk of being HIV/AIDS positive increases with the economic well-being of the individual's household. Even though the finding is in line with some papers (Barnighausen et al., 2007; Fox, 2010, 2012), it contradicts some points of the literature supporting that the level of poverty favours the transmission of the virus (Stillwaggon, 2002; Kim and Watts, 2005; Hunsmann, 2010; Buot et al., 2014; Mabaso et al., 2018; Adetokunboh and Are, 2020). However, this can be explained by the fact that the increase in the level of economic well-being is not always accompanied by good education. Moreover, in more well off households, too frequent parental absence can foster non-responsible behaviors on the side of the other household members.

On the other hand, like in Bertocchi and Dimico (2019), Kimani et al. (2013), Kelly et al. (2003) and Glynn et al. (2001), our findings suggest that single people are less affected by HIV, which is not in line with Shisana et al. (2016) and Kposowa (2013). Actually, some studies found that married people are less likely to use condoms (Shisana et al, 2014; Maharaj and Cleland, 2005; Jewkes et al., 2003). So, male and female infidelity in marriage (Bertocchi and Dimico, 2019; Chemaitelly et al., 2012; Dunkle et al., 2008; De Walque, 2007; Shandera, 2007) and polygamy may result in higher HIV prevalence for ever married people.

The result for the 1980 HIV prevalence rate may be indicating some unobserved heterogeneous and timeless factors (such as differences in culture) that affect people sexual behaviours. In the same vein, some African communities' view of child (child is wealth) may induce some sexual behaviours in favour of HIV expansion (denying the use of condoms, etc.) This may explain the role played by the fertility rate in 1980.

Concerning landlocked countries, our findings may be explained by the fact that this category of countries may be characterized by a relatively smaller flow of international (from overseas) travellers. So, people from those countries do not have the opportunity to learn from foreign people about safe sexual behaviours. We could also explain this result by the fact that the official origin of the virus (Congo) is not the coastal part of the continent.

Finally, for this work, we would have preferred taking into account natural resource availability of countries in 1980's. However, we faced data limitation problem on that matter.

6. References

Adetokunboh, O. O. and Are, E. B. (2020), 'Distribution and determinants of HIV prevalence in South Africa', *Annals of epidemiology*, Vol. 52, Conference abstract, 116-116. DOI: 10.1016/j.annepidem.2020.08.061.

Amat-Roze, J-M. (1989), 'L'infection à VIH et le SIDA en Afrique noire : facteurs d'épidémisation et de régionalisation', *Cahiers d'outre-mer*, Vol. 168, 333-355. DOI: 10.3406/caoum.1989.3318.

Anderson, S. (2018), 'Legal origins and female HIV', *American Economic Review*, Vol. *108*, 1407-1439. DOI: 10.1257/aer.20151047.

Barnighausen, T. et al (2007), 'The socioeconomic determinants of HIV incidence: evidence from a longitudinal, population-based study in rural South Africa', *AIDS*, Vol. 21 (suppl 7), S29-S38. DOI: 10.1097/01.aids.0000300533.59483.95.

Bertocchi, G. and Dimico, A. (2019), 'The long-term determinants of female HIV infection in Africa: The slave trade, polygyny, and sexual behaviour', *Journal of Development Economics*, 140, 90-105. DOI: 10.1016/j.jdeveco.2019.05.005.

Brewer, D. D. et al. (2003), 'Mounting anomalies in the epidemiology of HIV in Africa: cry the beloved paradigm', *International Journal of STD & AIDS*, 14, 144-147. DOI: 10.1258/095646203762869142.

Buot, M-L. G. et al. (2014), 'Beyond race and place: distal sociological determinants of HIV disparities', PLoS *ONE*, 9, e91711. DOI: 10.1371/journal.pone.0091711.

Chemaitelly, H. et al. (2012), 'Distinct HIV discordancy patterns by epidemic size in stable sexual partnerships in sub-Saharan Africa', *Sexually Transmitted Infections*, 88 (1), 51–57, DOI: 10.1136/sextrans-2011-050114.

Chersich, M. F. and Rees, H. V. (2008), 'Vulnerability of women in Southern Africa to infection with HIV: biological determinants and priority health sector interventions', *AIDS*, 22 (suppl 4), S27-S40. DOI: 10.1097/01.aids.0000341775.94123.75.

Couderc N., Ventelou, B. (2005). 'AIDS, economic growth and the epidemic trap in Africa'. *Oxford Development Studies*, 33, 417-426. DOI: 10.1080/13600810500199236.

De Walque, D. (2007), 'Sero-Discordant Couples in Five African Countries: Implications for Prevention Strategies', *Population and Development Review*, 33 (3), 501–523, DOI: 10.1111/j.1728-4457.2007.00182.x.

Dunkle, K. L. et al. (2008), 'New heterosexually transmitted HIV infections in married or cohabiting couples in urban Zambia and Rwanda: an analysis of survey and clinical data', *The Lancet*, 371 (9631), 2183–2191, DOI: 10.1016/S0140-6736(08)60953-8.

Fox, A. M. (2010), 'The social determinants of HIV serostatus in sub-Saharan Africa: an inverse relationship between poverty and HIV?', *Public Health Reports*, 125 (Suppl 4), 16-24. DOI: 10.1177/00333549101250S405.

Fox, A. M. (2012), 'The HIV – poverty thesis re-examined: poverty, wealth or inequality as a social determinant of HIV infection in sub-Saharan Africa?', *Journal of Biosocial Science*, 44, 459-480. DOI: 10.1017/S0021932011000745.

Gaibulloev, K. and Sandler, T. (2012), 'Aid for AIDS in Africa', *Empirical Economics*, 43, 1171-1197. DOI: 10.1007/s00181-011-0527-3.

Giles-Vernick, T. et al. (2013), 'Social history, biology, and the emergence of HIV in colonial Africa', *Journal of African History*, 54, 11-30. DOI: 10.1017/S0021853713000029.

Givord, P., & Guillerm, M. (2016). 'Les modèles multiniveaux', *Document de travail M2016/05*, INSEE, Paris, France. Available at https://www.insee.fr/fr/statistiques/2022152 (Accessed: 8 april 2020).

Glynn, J. R. et al. (2001), 'Why do young women have a much higher prevalence of HIV than young men? A study in Kisumu, Kenya and Ndola, Zambia', *AIDS*, 15 (suppl 4), S51–S60, DOI: 10.1097/00002030-200108004-00006.

Hanson, S. and Hanson, C. (2008), 'HIV control in low-income countries in sub-Saharan Africa: are the right things done?', *Global Health Action*, 1:1, 1837. DOI: 10.3402/gha.v1i0.1837.

Jewkes, R. K., Levin, J. B. and Penn-Kekana, L. A (2003), 'Gender inequalities, intimate partner violence and HIV preventive practices: findings of a South African cross-sectional study', *Social Science & Medicine*, 56 (1), 125–134. DOI: 10.1016/s0277-9536(02)00012-6.

Kelly, R. J. et al. (2003), 'Age differences in sexual partners and risk of HIV-1 infection in rural Uganda', *Journal of Acquired Immune Deficiency Syndr*ome, 32, 446–451. DOI: 10.1097/00126334-200304010-00016.

Kim, J. C. and Watts, C. H. (2005), 'Gaining a foothold: tackling poverty, gender inequality, and HIV in Africa', *BMJ*, 331, 769-772. DOI: 10.1136/bmj.331.7519.769.

Kimani, J. K. et al. (2013), 'Marital status and risk of HIV infection in slum settlements of Nairobi, Kenya: results from a cross-sectional survey', *African Journal of Reproductive Health*, 17(1), 103–113. DOI: 10.1136/jech.2011.142976l.61.

Kongnyuy, E. J. et al. (2006), 'Wealth and sexual behaviour among men in Cameroon', *BMC International Health and Human Rights*, 6. DOI: 10.1186/1472-698X-6-11.

Kposowa, A. J. (2013), 'Marital status and HIV/AIDS mortality: evidence from the US National Longitudinal Mortality Study', *International Journal of Infectious Diseases*, 17 (10), e868-e874, DOI: 10.1016/j.ijid.2013.02.018.

Mabaso et al. (2018), 'Determinants of HIV infection among adolescent girls and young women aged 15-24 years in South Africa: a 2012 population-based national household survey', *BMC Public Health*, 18, 183-183. DOI: 10.1186/s12889-018-5051-3.

Magadi, M. and Desta, M. (2011), 'A multilevel analysis of the determinants and cross-national variations of HIV seropositivity in sub-Saharan Africa: Evidence from the DHS', *Health & Place*, 17, 1067-1083. DOI: 10.1016/j.healthplace.2011.06.004.

Magrama, K. (2008). 'Les facteurs explicatifs de la prévalence du VIH/SIDA chez les femmes au Cameroun', Mémoire de DESSD, IFORD, Yaoundé, Cameroun. Available at https://ireda.ceped.org/inventaire/ressources/kaltsam_2008.pdf (Accessed: 27 january 2021).

Maharaj, P. and Cleland J. (2005), 'Risk Perception and Condom Use among Married or Cohabitating Couples in KwaZulu-Natal, South Africa', *International Family Planning Perspectives*, 31(1), 24–29, DOI: 10.1363/ifpp.31.24.05.

Over, M. and Piot, P. (1993). '*HIV infection and sexually transmitted diseases'*. In: *Disease Control Priorities in Developing countries*, New York: Oxford University Press for the World Bank. Available at https://www.healthworkscollective.com/wp-content/uploads/2013/01/dcp1-ch20.pdf (Accessed: 27 january 2021).

Pathé A-M. (1991). 'La France et l'indépendance de l'Afrique noire'. *Vingtième Siècle. Revue*

d'histoire, 30, 106-108. Available at https://www.persee.fr/doc/xxs_0294-1759_1991_num_30_1_2386 (Accessed: 27 january 2021).

Pepin, J. (2011), '*The Origins of AIDS'*, Cambridge: Cambridge University Press, eBook Academic Collection - North America. DOI: 10.1017/CBO9781139005234.

Robinson, R. S. (2011), 'From population to HIV: the organizational and structural determinants of HIV outcomes in sub-Saharan Africa', *Journal of the International AIDS Society*, 14 (Suppl 2):S6. DOI: 10.1186/1758-2652-14-S2-S6.

Rodier, J. (2017), 'SIDA: le nombre de victimes divisés par deux depuis 2005'. Available at https://www.jeuneafrique.com/459446/societe/sida-nombre-de-victimes-divise-deux-2005/ (Accessed : 2 february 2019).

Sawers, L. and Stillwaggon, E. (2010), 'Concurrent sexual partnerships do not explain the HIV epidemics in Africa: a systematic review of the evidence', *Journal of the International AIDS Society* 2010, 13:34. DOI: 10.1186/1758-2652-13-34.

Shandera, W. X. (2007), 'Key determinants of AIDS impact in Southern sub-Saharan Africa', *African Journal of AIDS Research*, 6 (3), 271–286, DOI: 10.2989/16085900709490423.

Shisana O, et al. (2014), 'South African National HIV Prevalence, Incidence and Behaviour Survey', 2012, Cape Town: HSRC Press.

Shisana, O. et al. (2016), 'Does marital status matter in an HIV hyperendemic country? Findings from the 2012 South African National HIV Prevalence, Incidence and Behaviour Survey', AIDS care, 28(2), 234–241, DOI: 10.1080/09540121.2015.1080790.

Stillwaggon, E. (2002), 'HIV/AIDS in Africa : Fertile Terrain'. *Journal of Development Studies*, *38*, 1-22. DOI: 10.1080/00220380412331322561.

Temah, C. T. (2009), 'Les déterminants de l'épidémie du VIH/SIDA en Afrique Subsaharienne', *Revue d'économie du développement*, *17*, 73-106. DOI : 10.3917/edd.231.0073.

UNAIDS (2020), '*Fiche d'information'*. Available at https://www.unaids.org/sites/default/files/media_asset/UNAIDS_FactSheet_fr.pdf (Accessed: 9 may 2021).

7. Appendices

Appendix 1: Estimates from the multi-level model with random effects, including the legal system as explanatory variable (without Ethiopia)

Table 5: Estimates from the multi-level model with the legal system as explanatory variable.

Independent variables	Coefficients	Odds-Ratios	P >|z|
Type of environment of residence (Ref= Rural)			
Urban	0.408 (0.033)	1.503	0.000
Wealth index (Ref= very poor)			
Poor	0.133 (0.038)	1.143	0.001
Middle	0.134 (0.039)	1.144	0.001
Rich	0.148 (0.041)	1.160	0.000
Very rich	0.153 (0.048)	1.166	0.001

Gender (Ref=Male)			
Female	0.329 (0.025)	1.390	0.000
Education (Ref=No education)			
Primary	0.300 (0.040)	1.350	0.000
Secondary	0.198 (0.045)	1.219	0.000
Higher	-0.213 (0.076)	0.807	0.005
Age (Ref=[15-24])			
[25-34]	1.072 (0.037)	2.922	0.000
[35-44]	1.282 (0.040)	3.604	0.000
[45-49]	1.088 (0.051)	2.968	0.000
Marital status (Ref= Never married)			
Married	0.260 (0.037)	1.297	0.000
Widowed	1.588 (0.058)	4.898	0.000
Divorced	1.081 (0.050)	2.949	0.000
Political system (Ref=Imperfect democracy)			
Hybrid regime	0.270 (0.442)	1.310	0.542
Authoritarian regime	0.256 (0.262)	1.291	0.330
Country location (Ref=West)			
East	1.435 (0.360)	4.199	0.000
Central	0.808 (0.394)	2.243	0.040
South	6.892 (1.194)	505.6012	0.000
Year of independence	-0.395 (0.061)	984.898	0.000
HIV prevalence in 1980	0.241 (0.046)	1.272	0.000
GDP per capita in 1980	0.0001 (0.00003)	1.0001	0.000
Fertility rate in 1980	0.856 (0.281)	2.355	0.002
Legal system (Ref= Civil-law and Customary)			
Common Law et Customary	-0.458 (0.511)	0.632	0.370
Common Law, Civil-law and Customary	0.764 (0.334)	2.146	0.022
Littoral (Ref=Not landlocked)			
landlocked	0.729 (0.250)	2.073	0.004
Constant	760.869 (119.537)	-	0.000
Log -likelihood = -28116.019			
Number of observations: 165426		Observations per group	
Number of groups: 14		Min	6741
Wald chi2 (27) = 4790.96		Average	11816.1
Prob chi2 = 0.000		Max	19680
LR test for rho=0 : P-value=0.000			

Source: *Produced by the authors, standard errors in (.).*

Appendix 2: Model including Ethiopia

Table 6: Estimates from the model including Ethiopia.

Independent variables	**Coefficients**	**Odds-Ratios**	**P >|z|**
Type of environment of residence (Ref= Rural)			
Urban	0.466 (0.032)	1.594	0.000
Wealth index (Ref= very poor)			
Poor	0.134 (0.038)	1.144	0.000
Middle	0.135 (0.039)	1.144	0.001
Rich	0.143 (0.040)	1.154	0.000
Very rich	0.226 (0.046)	1.254	0.000
Gender (Ref=Male)			
Female	0.326 (0.024)	1.386	0.000
Education (Ref=No education)			
Primary	0.392 (0.037)	1.481	0.000
Secondary	0.278 (0.043)	1.321	0.000
Higher	-0.150 (0.071)	0.859	0.035
Age (Ref= [15-24])			
[25-34]	1.072 (0.036)	2.922	0.000
[35-44]	1.284 (0.039)	3.613	0.000
[45-49]	1.075 (0.049)	2.932	0.000
Marital status (Ref= Never married)			
Married	0.281 (0.036)	1.325	0.000
Widowed	1.655 (0.056)	5.236	0.000
Divorced	1.140 (0.048)	3.127	0.000
Political system (Ref=Imperfect democracy)			
Hybrid regime	0.201 (0.843)	1.222	0.812
Authoritarian regime	0.017 (0.540)	1.017	0.974
Country location (Ref=West)			
East	0.679 (0.433)	1.973	0.117
Central	0.532 (0.578)	1.703	0.357
South	2.607 (1.222)	13.562	0.033
Year of independence	0.003 (0.009)	1.003	0.751
HIV prevalence in 1980	0.038 (0.067)	1.038	0.575
GDP per capita in 1980	0.0000146 (0.0000596)	1.00001	0.807
Fertility rate in 1980	-0.021 (0.448)	0.979	0.962
Littoral (Ref=Not landlocked)			
Landlocked	0.422 (0.425)	1.525	0.320
Constant	-12.078 (18.371)	5.68e-06	0.511
Log-likelihood= -30504.681			
Number of observations = 193782		Observation per group	
Number of groups= 15		Min	6741

Wald chi2 (26) = 5209.61	Average	12918.8
Prob chi2 = 0.000	Max	28355
LR test for rho=0 : P-value=0.000		

Source: *Produced by the authors, standard errors in (.).*