THE EFFECT OF SOCIOECONOMIC CONDITIONS ON HIV/AIDS MORTALITY RATE ACROSS THE GLOBE

by

Dmytro Ivasenko

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Thesis Supervisor: ______________________________ Professor Maksym Obrizan

Approved by ____
Head of the KSE Defense Committee, Professor

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Date ________________________________

Kyiv School of Economics

Abstract

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HIV/AIDS has been the world's health problem since the 1980s. It is imperative to deal with the virus since even in 2019-year 690 000 people died from it. Although the HIV/AIDS Mortality rate differs across the globe, prudent actions that help to deal with the rates worldwide are still ambiguous. The study aims to analyze how socioeconomic conditions affect the HIV/AIDS Mortality rate and introduce effective measures to deal with the virus and its transmission in the population.

The study analyses socioeconomic data from such databases as Our World in Data, The United Nation Statistics, World Bank Open Data, Human Development Data, and International Monetary Fund Data. It covers 104 countries from 2000 to the 2017 year. It contains data that contribute to disease transmission, countries' development level, and population well-being.

The study results suggest that increasing the Antiretroviral therapy coverage, Government Expenditures on Education and Health is a sensible way to significantly decrease HIV/AIDS Mortality rate and its prevalence across the globe.

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Chapter 1

INTRODUCTION

HIV has been one of the world's most public health problems since the first cases in 1981. The very first note about the disease is reported in 1959. Scientists found it in a male blood sample, a citizen of the Democratic Republic of the Congo. For a long time, it had been spreading worldwide until, in the early 1980s, the US doctors started encountering rare types of common illnesses among male patients who were homosexuals. The patients' health conditions were much different from other patients with healthy immune systems who suffered similar diseases. Finally, in 1982 the US health authority entered the new term Acquired Immunodeficiency Syndrome – AIDS. The following year scientists found out what virus causes AIDS and named it Human Immunodeficiency Virus – HIV (Healthline, 2018).

In 2019 the number of HIV worldwide was about 38 million people, with 1.7 million newly infected people within the year. The most common channel through which HIV spreads is unprotected sexual intercourse with an infected person. The other common transmission channel stays for contacts with infected blood. Countries, usually poor ones, with a high prevalence of injected drug usage in a population, tend to have more HIV cases annually since drug equipment such as needles and syringes are often used repeatedly among a group of addicts. Also, sometimes doctors get infected through accidental direct interaction with HIV - positive patients' blood. The disease also could be passed from a mother to its infant through breastfeeding if the mother is infected.

The global statistics dreadfully state that during the year 690 000 people died due to the disease. Since the very start of the pandemic, the overall number of infected people is about 75.7 million, from which 32.7 million died from AIDS-related diseases (UNAIDS, 2020).

The virus is one of the main priorities to deal with among all countries' health authorities as it is hazardous to human health. While AIDS/HIV's impact on human health is well studied, it is much less observable, the conditions that lead to different mortality rates across the globe. Even though the disease's situation is different across the globe, it still requires a lot of public and private expenditures as well as prudent policy implications in each country.

The decrease in mortality rate must be pursued globally as the virus impacts each country's economic growth by steadily declining human capital. As a result of the moderate and high mortality rate, there will be fewer skilled people and an overall labor force in a country. As the highest rate of HIV incidence is among persons aged 25-34 years old – the disease persistently reduces the productivity of the people; hence, the productivity of a country's labor force is reduced (HIV.gov, 2020). Also, the death of a relatively young population due to HIV reduces the allocation of money for public expenditures since the labor force decreases; therefore, there are less available funds to spend on government projects and services. All that results in significant pressure on the government and lowers the rate of potential economic growth. From a household's perspective, the virus causes loss of income and forces families to spend more on healthcare services and other illness-related spending. Households may omit such problems more or less with government financial help; however, if the government does not possess enough funding, people, especially, poor ones may decide to populate the sex workers market, which escalates many new HIV cases in the short and long run.

The disease has a severe impact on countries' economic growth, especially those with its high prevalence. According to the 2019-year paper by Nketiah-Amponsah, Abubakari, and Baffour, an increase in HIV/AIDS prevalence by 1% is associated with the decrease in per capita income growth by almost 0.5%. Although the paper mainly concentrates on Sub-Saharan Africa, the developed counties suffer from HIV/AIDS consequences as well.

As for the disease's treatment, according to the 2014-year article by Trapero-Bertran and Oliva-Moreno, the average cost of HIV treatment per patient across five European countries is 18 063 EUR. The therapy has skyrocketed recently due to the COVID-19 pandemic, as the same drugs are proved to lighten the manifestation of the disease. It places an even more considerable burden nowadays on households with HIV-positive members and the government to help such families. Still, no research is directly aimed at comparing the effect of socioeconomic conditions that influence different mortality rates across the globe.

It is imperative to determine the reasons behind the relatively low mortality rates of upper-middle- and high-income countries apart from well-known ones. Hence, the paper results may facilitate the development of effective policies that would be a successful response to the HIV/AIDS spread around the globe, especially in low- and lower-middle-income economies, and would lead to a steady decrease in its prevalence across the globe.

One of the significant differences between low- and high-income countries apart from health expenditures, higher income per capita, infrastructure, and education level is the availability of an effective treatment and diagnosis rate. As for the past two decades, significant progress in HIV/AIDS diagnosis and treatment has led to a drastic reduction in disease mortality. Partially, this happened due to modern medications such as antiretroviral drugs that effectively suppress the virus and prevent the spread of the disease. Such treatment with highly active antiretroviral therapy (HAART/ART) helps to back infected people's life expectancy close to a normal one. However, it does not kill the virus, so the disease is not curable (Teresa, Manuel-García, and Muñoz-Fernández, 2009). The drugs' cost varies from 1500 to 4500 dollars a month, and it has been significantly increasing due to the COVID-19 pandemic, as the drugs are useful to deal with the disease (WebMD, 2020). Still, other factors determine the mortality rate from HIV, such as late diagnosis, adolescent fertility rate, age, health expenditures, gross domestic product per capita, level of urbanization, life expectancy at birth, etc.

The thesis's topic is motivated by the United Nations General Assembly, the Sustainable Development Goals. Under the Sustainable Development Goals framework, mainly target 3.3, which aims to end the pandemic of HIV/AIDS as a global health disaster by the year 2030. The paper pursues mostly to shed light on the leading causes of the mortality rate from HIV/AIDS across the globe. The paper results might lead to important policy implications and facilitate developing a better strategy to deal with one of the most dreadful human diseases so far.

The paper is organized in the following way:

- Chapter 2, the literature review, mainly focusing on the empirical literature of the HIV/AIDS's economic impact;
- Chapter 3 provides the description of the obtained data, the data-merging process, and descriptive statistics of the variables used in the study;
- Chapter 4 presents the description of the methodology that is used in the research;

- Chapter 5 includes analysis of the obtained data, estimation results of the models that shed light on the socioeconomic conditions that directly or indirectly lead to a higher mortality rate across the globe;
- Chapter 6 summarizes the study's main findings and discusses possible policy implications to deal with the virus that came from the model results.

Chapter 2

LITERATURE REVIEW

Until the late 1970s, HIV was unknown to the public as scientists could only find the virus in some chimpanzee species. By early 1980 the disease was perceived in all the continents, with the total number of infected people around 200 000 (Mann, 1989).

In the 1983 year, the World Health Organization developed a plan to assess AIDS and declared global surveillance. At the end of 1983, AIDS caused 1292 deaths, which attract much attention from the public and government (Healthline, 2021).

One of the first papers dedicated to estimating the economic impact of AIDS was made in the late 1980s (Bloom and Garliner, 1988). The authors estimated that the disease's lifetime medical treatment concluded that it is equivalent to the cost of other serious illnesses – 80 000 of 1986-year dollars. During 1983-year 15, 000 people were infected by the virus such that the overall cost of treatment was about 1.2 billion. The authors analyzed the trend of the disease spread and concluded that the virus would cost almost 6 billion dollars annually (1986 equivalent) in the US. Moreover, they estimated the cost of lost productivity due to AIDS mortality from $541,000 to $623,000 per patient. The authors doubted that the illness would cause a significant impact on the US economy because they assumed that the disease would continue to spread among homosexual couples only as by the time there was quite a slow dynamic of AIDS prevalence in heterosexual couples. However, they agreed that it would become a serious global health problem if the disease quickly spreads among the general heterosexual population.

The observed trend of HIV/AIDS spread led to a growing interest in the impact of AIDS on an economy at the end of the 20th century. Economists started to study the virus's impact on developing countries as they are usually the most vulnerable due to poor health and economic conditions. The 1999-year research on the effects of HIV on India's national economy by Anand, Pandav, and Nath estimated the disease's cost for ten years. The paper shows that the disease is likely to affect the economy, especially the health sector, significantly. The estimated loss of Indian GNP due to HIV/AIDS was about 0.1-1.1% annually. Moreover, there is a major loss in productivity due to the virus. Also, an ill person impacts the next generations; for example, if there is a death of an adult due to AIDS, their children might be forcefully withdrawn from a school to earn money or look after grandparents.

As the disease originally occurred in Sub-Saharan Africa, it is the most prevalent there and has a prominent effect. The 2002-year research of the impact of HIV on Africa's economic development by Dixon, McDonald, and Roberts was shown that the AIDS pandemic in sub-Saharan Africa has a long-term effect on the economy of the region and can be fixed only by the assistance of other countries. The disease leads to a drastic decrease in labor supply due to increased mortality. It is important to distinguish possible reasons about what conditions may lead to the increased mortality rate from the disease in the region. The 2016-year research by Parry and Rehm shed light on the socioeconomic differences that increase the risk of the virus's mortality in South Africa. The country suffers a lot from HIV/AIDS as every fifth person diagnosed with the disease worldwide lives there. The results of the research affirm that people with low socioeconomic status, which includes relatively low income, poor access to water and electricity, and irregular employment, are at more than 50% greater risk of dying from the virus compared to people of high socioeconomic status. Moreover, the resulting cost of HIV/AIDS deaths may include those individuals who contributed income to a household. The statement is enhanced by the fact that the disease is more rapidly spreads among young people. For example, Altenroxel's research - AIDS taking a toll on student nurses – concluded that the virus-infected 19% of nurse graduates. As the disease is incurable, there is a lifetime effect on an individual's productivity. The Bollinger and Stover - The economic impact of AIDS – estimated that an African car manufacturing worker, who is HIV-positive, caused a loss from 17 to 300 dollars to a firm compared with a healthy one. As a result of the increased number of infected people, the government under collects taxes and must simultaneously increase health expenditure, which puts lots of pressure on a budget. As the productivity of work declines, the exports reduce as well, while imports of the drugs and equipment for HIV patients grow. If the HIV prevalence significantly increases in an African country's core sectors, then the balance of payment will be negative. Along with pressure on a budget, an African country may require regular financial help from the international community.

The European countries suffer from the disease, not less than African or Asian. Although the virus's prevalence here is smaller, partially due to extreme official underreport, many financial resources are needed to deal with it. The 2020 World Bank research – Tackling the World's Fastest-Growing HIV Epidemic – concentrated the virus's impact on Eastern Europe and Central Asia. As of the research conclusion, there is a surging need for such countries as Ukraine, Belarus, and Moldova in domestic financing since the Global Fund to fight HIV considers the countries to move economically and cuts their funding. Since the countries' health expenditures as the share of GDP remain below the global average, domestic financing is not enough to meet the HIV challenges.

Therefore, the economies are highly vulnerable to the consequences of the extremely high prevalence of the virus in African countries. Another research that concentrated on the European region was published in the 2020 year. It investigates trends, causes, and methods for the prevention of mortality from HIV/AIDS in Spain. The results suggest that access to antiretroviral therapy and the development of the management of HIV-infected people is associated with a decline in deaths from HIV and HIV-related diseases (Fontela, Aguinaga, and Moreno-Iribas, 2020). However, the 2014-year research about socioeconomic determinants of mortality from HIV in Uganda by Burkey, Weiser, Fehmie, Alamo-Talisuna, Sunday, Nannyunja, Reynolds, and Chang argues that the introduction of antiretroviral therapy alone may significantly decrease mortality from the virus. The study suggests that people's low socioeconomic status might indicate a long-term exposure to mortality from HIV/AIDS even when low-income groups of people uniformly have free access to ART. The research indicates that economic and educational interventions are needed to facilitate successful HIV/AIDS outcomes in low- and low-middle-income countries.

Although the mortality rate highly depends on the health expenditures, there is recent evidence that such factor as unemployment rate indirectly enhances death occurrences due to the illness. The 2017-year paper – Unemployment and HIV mortality in the countries of the Organisation for Economic Co-operation and Development: 1981–2009 – by Maruthappu, Zhou, Williams, Zeltner, and Atun analyzed the mortality in OECD countries and the unemployment rate of the countries and concluded that an increase in unemployment is related to a rise in AIDS mortality rate in the OECD countries. One of the possible reasons is that unemployment causes lower socioeconomic status, leading to late diagnoses, worse access to healthcare services, and timely treatment. However, the authors point out that unemployment remains an independent factor for AIDS mortality after accounting for these factors. They indicate that the mechanism by which the unemployment rate influences AIDS is still obscure.

Overall, the literature findings suggest that HIV/AIDS may have an enormous impact on a country's economy due to the increased mortality rate from the virus. The most vulnerable countries to the pandemic are those with the highest prevalence of the disease and poor socioeconomic conditions. Although the findings suggest that low- and low-middle-income countries are mostly affected by the virus, nonetheless, high-middle- and high-income countries suffer from the disease as well. There is a substantial difference across the countries as they have contrasting socioeconomic conditions that affect the prevalence, morbidity, and mortality of HIV/AIDS.

Chapter 3

DATA DESCRIPTION

The research examines the difference in the effect of socioeconomic conditions on mortality rates from HIV/AIDS across the globe and introduces measures to deal with the virus. The data for the variable of interest was taken from the Our World Data, the World Bank Open Data, and the United Nations Department of Economic and Social Affairs database. The merged datasets represent panel data for the cause of deaths due to HIV/AIDS among all causes for 195 countries from 2000 to the 2017 year and the countries' population for the same period. To calculate the Mortality Rate for each country, the following formula was used:

$$Mortality\ Rate_{it} = \frac{Total\ Deaths\ due\ to\ HIV/AIDS\ within\ a\ year_{it}}{Total\ Population_{it}} \times 10\ 000, \qquad (1)$$

where i stands for each country separately and t represents a year.

As for the other variables, we use the cross-sectional time-series dataset from the World Bank Open Data, Human Development Data Center, and International Monetary Fund Data, which includes the cross-country data.

The following variables were obtained from the sources: Prevalence of HIV as % of population ages 15-49, Government expenditure on education as % of GDP, the Urban population as % of the total population, Antiretroviral therapy coverage as % of people living with HIV, GDP per capita in constant 2010 US$, Current Health Expenditure as % of GDP, People using at least basic drinking water services as % of the population, Adolescent fertility rate (births per 1,000 women ages 15-19), and Life expectancy index.

The thesis uses the following independent variables: Government expenditure on education as % of GDP, Current Health Expenditure as % of GDP, and Antiretroviral therapy coverage as % of people living with HIV. The variables might have a substantial impact on the Mortality rate and be effective levers of influence for governmental and non-governmental institutions worldwide in the reduction of deaths due to the virus.

The problem with slowing down the progression of HIV in the human body is that the virus develops resistance to drugs exceptionally quickly. An antiretroviral therapy seems to deal with the problem and helps patients slow down the virus's spread significantly. Therefore, it might be one of the few effective methods to deal with the disease quickly.

The other independent variable – Health Expenditures – is an indicator of a country's health care system support and development. Countries with higher health care spending might be better protected from diseases of all kinds.

The third independent variable is Government expenditure on education. A prudent strategy to lower the mortality rate of any disease is to prevent its spreading. Therefore, making people more educated may improve their self-heath preservation and extinguish such communicable diseases as HIV.

Also, the study uses the following control variables: Prevalence of HIV as % of population ages 15-49, the Urban population as % of the total population, GDP per capita in constant 2010 US$, People using at least basic drinking water services as % of the population, Life expectancy index, and Adolescent fertility rate (births per 1,000 women ages 15-19).

It is necessary to control for the prevalence of the disease as the more infected people are in a specific country, the higher the mortality rate there and vice versa. Therefore, to remove omitted variable bias, Prevalence of HIV as % of population ages 15-49 is used in the study as a control variable.

Another variable – Urban population – helps to control for population density in a country. It is better for the study than a population density itself as the latter one is measured as people per square kilometer of land area; however, a country might have large but uninhabitable areas. The variable is critical to control for, as in places with high population density, such as urban areas, the probability of transmission of the virus is more significant due to higher potential sexual partners.

The third control variable – GDP per capita – works as an indicator of a country's development. Generally, countries with higher income have more advanced technological infrastructure and more developed healthcare systems, which indirectly lower mortality rates of any disease, including HIV.

The fourth control variable is People using at least basic drinking water services as % of the population. It shows the percentage of the population that has access to the basic safely managed drinking water services within 30 minutes range for a round trip. The variable is crucial to control for as countries' healthcare systems, where the indicator is low, suffer more from water-based transmission diseases. The lack of access to drinking services significantly increases the population's morbidity, which in turn may increase the number of HIV/AIDS-related deaths. Therefore, access to basic safely managed water services is used as a proxy for a country's infrastructure development and healthcare system workload and efficiency.

The fifth control variable is the Life expectancy index, which shows the expected lifetime at birth in the form of an index where a minimum number of years is 20 and a maximum of 85. The assumption of the index that current death rates are held constant within a country. The index is used as a proxy for the healthcare system and an essential variable to control for as it indicates people's health status within a specific country.

The other control variable is the Adolescent fertility rate shows the number of births per 1000 women in the group age of 15-19 within a year. The rate shows the number of young women per 1000 women that are exposed to the risk of pregnancy. The increased number of births within the young group age may reveal the prevalence of young people having unprotected sex in a nation. Therefore, the indicator is used as a proxy for unprotected sexual contacts prevalent in a country.

After merging the datasets, the overall number of countries used in the research decreased from 195 to 104 because of missing data. The merged dataset consists of 1339 observations for the range of years between 2000 to 2017, including.

The data collected represents the variety of countries with different situations about HIV/AIDS. The Mean Mortality rate per 10 000 people is 4.95. However, the minimum rate is 0.005, while the maximum is 91.45. Most of the countries with a high Mortality rate from the disease are located in Africa. They have worse health care systems, less Antiretroviral therapy coverage, shorter Life expectancy and the people's overall well-being is worse there. On the contrary, most other countries have better socioeconomic conditions. The study uses so many control variables to determine what measures could be made to lower the Mortality rate both in the low-, middle- and high-income countries. The descriptive statistics of the variables used in the study are shown in Table 1.

Table 1. Descriptive statistics of variables used in the study

	Mean	Std. Dev.	Min.	Max.
Mortality Rate per 10 000 people	4.95	12.81	0.005	91.45
Prevalence of HIV as % of people ages 15-49	1.64	4.03	0.01	28.9
Government Expenditure on Education as % of GDP	4.56	1.72	0.62	13.22
Urban population as % of the total population	57.24	23.58	8.25	100
Antiretroviral therapy as % of people living with HIV	29.70	23.93	0	90
Adolescent fertility rate (women ages 15-19)	56.54	45.67	3.78	217.16
GDP per capita (in constant 2010$)	14044	19017	197	91566
Access to basic drinking water services as % of population	84.36	18.44	18.70	100
Life expectancy	0.77	0.15	0.35	0.99
Current Health expenditure as % of GDP	6.13	2.23	1.03	11.58

The graphical representation of the countries covered in the study is depicted in Figure 1.

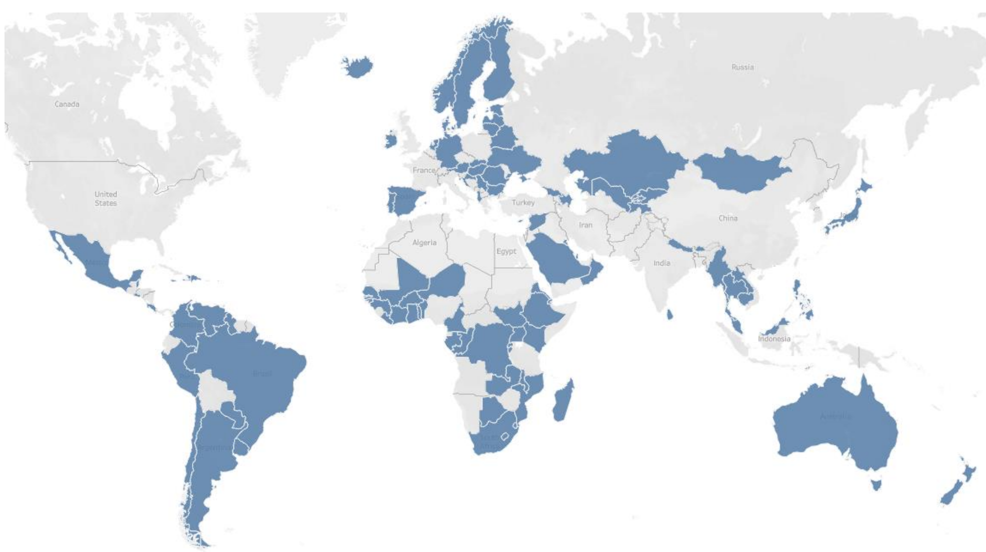

Figure 1. Graphical representation of the countries covered in the study

To sum up, the dataset provides detailed information on a country's mortality rate from HIV/AIDS, Prevalence of HIV as % of population ages 15-49, Government expenditure on education as % of GDP, the Urban population as % of the total population, Antiretroviral therapy coverage as % of people living with HIV, GDP per capita in constant 2010 US$, Current Health Expenditure as % of GDP, People using at least basic drinking water services as % of the population, Adolescent fertility rate (births per 1,000 women ages 15-19), and Life expectancy index. The datasets are taken from the Our World Data, the World Bank Open Data, and the United Nations Department of Economic and Social Affairs database, Human Development Data Center, and International Monetary Fund Data. The number of observations is 1339, covering 104 countries and the socioeconomic variables for the years range of 2000-2017. The dataset is quite reliable for further regression analysis as it gathers the information needed for prudent research. The overall number of observations in the sample is sufficient to make conclusions about such variability of the mortality rates across the countries and the effect of socioeconomic conditions on it.

Chapter 4

METHODOLOGY

Since the study uses panel data, we start with the generalized linear model as it allows for the different error distributions, unlike the ordinary least squares model. Also, the mortality rate is likely to have a different relationship with the independent variables across countries; therefore, the model is much better than a general OLS. We use the following form of the model:

$$\begin{gathered} Log(Y_{it}) = B_0 + B_1 X_{1,it} + B_2 (X_{1,it})^2 + B_3 X_{2,it} + \\ + B_4 (X_{2,it})^2 + B_5 X_{3,it} + B_6 (X_{3,it})^2 + B_7 X_{4,it} + B_8 (X_{4,it})^2 + \\ + B_9 X_{5,it} + B_{10} \text{Log}\,(X_{6,it}) + B_{11} X_{7,it} + B_{12} Log(X_{8,it}) + \\ + B_{13} Log(X_{9,it}) + u_{it}, \end{gathered} \tag{2}$$

where Log (Y_{it}) stands for the logarithm of Mortality rate from HIV/AIDS for a country i = 1,..., n, in a year t = 2000,…, 2017; B_0 stands for an intercept; $X_{1,it}$ stands for Antiretroviral therapy coverage (as % of people living with HIV) divided by 100; $X_{2,it}$ stands for Current Health Expenditure (as % of GDP) divided by 100; $X_{3,it}$ stands for the Government expenditure on education (as % of GDP) divided by 100; $X_{4,it}$ stands for the People using at least basic drinking water services as % of the population divided by 100; $X_{5,it}$ stands for the Prevalence of HIV (as % of population ages 15-49) divided by 100; $X_{5,it}$ stands for the Life expectancy index; $X_{6,it}$ stands for the Urban population (as % of the total population) divided by 100; $X_{7,it}$ stands for

Adolescent fertility rate (births per 1,000 women ages 15-19); $X_{8,it}$ stands for GDP per capita and u_{it} stands for the error term.

It was decided to include quadratic terms in the model for such variables as Government expenditure on education (as % of GDP), Current Health Expenditure (as % of GDP), Antiretroviral therapy coverage (as % of people living with HIV), and People using at least basic drinking water services as % of the population.

There is theoretical reasoning for doing it as increasing expenditures on education and health in a particular country will eventually obey the law of diminishing return. An additional increase in the number of expenditures might not have the very same effect on the mortality rate from HIV/AIDS. The same applies to the Antiretroviral therapy coverage and percentage of people using at least basic drinking services; therefore, squared terms are used for the variables.

The reduction in the number of observations due to missing values has led to the disproportional number of observations between different countries. Also, the population of the countries differs and, to control for that, it was decided to use weights in the model. They were calculated by the following formula:

$$w_{i,j} = \frac{Average\ population_j}{\sum(Average\ popuations_j)} \tag{3}$$

where $w_{i,j}$ stands for the weight of observation i = 1,..., 1339, for a country j = 1, …, 104; $Average\ population_j$ stands for a country's average population between the period from 2000 to 2017.

The estimation of the model might raise concerns about the possible unobserved heterogeneity across countries. It might occur due to the possible existence of constant terms that are present across countries and lead to omitted variable bias. In that case, the model must account for fixed effects. The fixed-effect model may improve the regression analysis. If the fixed-effect specification is needed, then the previous generalized version of the main regression model for panel data will be transformed into the following one:

$$Log(Y_{it}) = B_0 + B_k X_{kit} + B_{k-1} Z_i + u_{it} \tag{4}$$

where Log (Y_{it}) stands for the logarithm of Mortality rate from HIV/AIDS for a country i = 1,..., n, in a year t = 2000,…, 2017; X_{kit} stands for the control and independent variables k = 1,…,9; However, there also might be the term Z_i that stands for the unobserved time-invariant heterogeneities across the countries i = 1, 2, …., n and it introduces omitted variable bias. The improved model's point is to estimate B_k, which stands for a change in X_{kit} associated with a change in Y_{it} while holding constant Z_i. To do that, we need to introduce a country's individual intercept – α – that will gather the heterogeneities across the countries. Let $\alpha_i = B_0 + B_{k-1} Z_i$, putting the term into the panel regression model excludes the unobserved time-invariant heterogeneities across the countries from the model. Therefore, the general representation of the model is in the following form:

$$Y_{it} = \alpha_i + B_k X_{kit} + u_{it} \tag{5}$$

where the term α_i, while i stands for each country separately, gathers fixed effects of a country i. For each entity, i = 1,…, 104, the term α_i will be different as the variation comes from the Z_i.

However, fixed effects specification is used when the groups' means are non-random, but what if they are, indeed, random. Consequently, if there are no fixed effects in the model and the random effects assumptions hold, the latter must be used as the fixed effect estimator becomes inconsistent. The specification assumes that the individual unobserved heterogeneity is not correlated with the independent variables, and heterogeneity remains constant over time. If the prerequisites are met, then the random effects estimator is more efficient than the fixed effects specification.

In case the fixed effect specification is preferred over the random effects, there is a need to check whether the time-fixed effects are needed. The Breusch and Pagan test must be performed in this case. The null hypothesis states that no time-fixed effects ought to be included in the model.

However, if the random effects specification is preferred over the fixed effects, it must be checked whether the estimators of the specification are consistent and unbiased compared to the pooled generalized linear model. The Breusch-Pagan Lagrange Multiplier test checks what model specification results in prudent estimates. The null hypothesis of the test states that there is no panel effect such that variances across entities are zero - the pooled generalized linear model is preferred.

Chapter 5

ESTIMATION RESULTS

The chapter presents estimation results of the regression models described in the previous chapter. The results can be seen in the tables depicted in the chapter.

In the first stage, we used a generalized linear model with estimated weights for each observation. We regress the Mortality rate on such explanatory variables as Antiretroviral therapy, Government Expenditures as a share of GDP, and Health Expenditures as a share of GDP. In the regression, we control for the Prevalence of HIV, Access to at least basic drinking water services, Life expectancy, Urban population, Adolescent fertility rate and GDP per capita.

The results of the model are that each of the explanatory variables is significant. The model suggests that the 1 p.p. increase in the Health Expenditures as a share of GDP is associated with 6.45 % decrease in the Mortality rate. The result is consistent with the literature as the increase in Health Expenditures leads to the development of the health care system and boosts its efficiency in dealing with diseases (Owusu, Sarkodie and Pedersen PA, 2021). On the contrary, the model suggests that 1 p.p. increase in the Antiretroviral coverage is associated with 0.43 % increase in the Mortality rate from the disease. Moreover, an increase in Government Expenditures is associated with a significant increase in the Mortality rate. The results are not supported by the literature (Raghupathi and Raghupathi, 2020). This might have occurred due to limitations that come with using a pooling generalized linear model and which might make the estimates of parameters biased and inconsistent.

The estimation results of the generalized linear model are provided in Table 2.

Table 2. Estimation results of GLM (dependent variable: Log (Mortality Rate))

Variable	Estimate	Std. Error	Wald test
Intercept	-3.33	0.65	***
Antiretroviral therapy	1.46	0.38	***
$(\text{Antiretroviral therapy})^2$	-1.74	0.56	**
Government Expenditure	31.04	7.86	***
$(\text{Government Expenditure})^2$	-196.05	84.61	*
Health Expenditure	-44.55	6.84	***
$(\text{Health Expenditure})^2$	310.72	51.80	***
Prevalence of HIV	18.23	1.15	***
Access to at least basic drinking water services	0.07	1.07	-
$(\text{Access to at least basic drinking water services})^2$	-0.23	0.87	-
The Logarithm of Life Expectancy	-3.65	0.39	***
Urban population	0.11	0.25	-
The Logarithm of Adolescent fertility rate	0.82	0.05	***
The Logarithm of GDP per capita	-0.12	0.06	*
Observations		1339	
R-squared		0.8193	
Adjusted R-squared		0.8175	

Note: "-" $p < 1$, "." $p < 0.10$, "*" $p < 0.05$, "**" $p < 0.01$, "***" $p < 0.001$.

According to the thesis' methodology, it might be necessary to account for some potential random or fixed effects that might cause the omitted variable bias. Therefore, the second stage of the regression analysis introduces random effect model.

Table 3 shows the results of the model with random specifications being included. As is shown in Table 3, each of the key variables is significant.

Table 3. Random effects model (dependent variable: Log (Mortality Rate))

Variable	Estimate	Std. Error	Wald test
Intercept	3.67	0.62	***
Antiretroviral therapy	0.54	0.15	***
(Antiretroviral therapy)^2	-1.62	0.17	***
Government Expenditure	-6.91	3.90	.
(Government Expenditure)^2	77.59	38.52	*
Health Expenditure	-17.54	3.12	***
(Health Expenditure)^2	135.84	21.44	***
Prevalence of HIV	14.04	1.33	***
Access to at least basic drinking water services	-3.53	0.68	***
(Access to at least basic drinking water services)^2	2.49	0.50	***
The Logarithm of Life Expectancy	-1.67	0.23	***
Urban population	-0.55	0.34	-
The Logarithm of Adolescent fertility rate	-0.03	0.07	-
The Logarithm of GDP per capita	-0.29	0.06	***
Observations		1339	
R-Squared		0.27716	
Adjusted R-Squared		0.27007	

Note: "-" $p < 1$, "." $p < 0.10$, "*" $p < 0.05$, "**" $p < 0.01$, "***" $p < 0.001$.

The model suggests that 1 p. p. change in the therapy coverage is negatively associated with a change in the mortality rate of HIV/AIDS by 0.42 %. As for the Health Expenditures, the increase in the share is associated with the decrease in the Mortality rate by 0.88 %. However, a change in the Government Expenditure share is still positively associated with the change in the Mortality rate.

To check whether the model is better than the previous one, the Breusch-Pagan Lagrange Multiplier test was performed. The test defines whether the variance of the error term from the regressions is dependent on the values of the explanatory variables, or in other words, it tests for the presence of heteroskedasticity. The null hypothesis of the test is that variances across countries are zero. It states that there are no significant differences across entities and no necessity in random effects. Table 4 shows the result of the test.

Table 4. The Breusch-Pagan Lagrange Multiplier test result

Comparison of the fixed and random effect specification	
Chi-square distribution	5861.9
Degrees of freedom	1
P-value	2.2e-16
Alternative hypothesis	Significant effects

Since the p-value of the test is close to zero; therefore, we reject the null hypothesis in favor of random effects. According to the methodology, the third stage is the estimation of the fixed effects specification and performing the Durbin-Wu-Hausman test for choosing the random effects or the fixed effects specification.

As it is shown in Table 5, the Antiretroviral therapy coverage, the Government Expenditure as a share of GDP, and the Health Expenditure as a share of GDP. The fixed effects specification suggests that 1 p.p. increase in the

Antiretroviral therapy coverage is associated with 1.28% decrease in the Mortality rate from HIV/AIDS on average. Indeed, the therapy is among the best ones to combat the disease, and previous literature shows that the treatment significantly increases HIV-patients' expected longevity which becomes close to healthy people one's. Moreover, the treatment prevents the virus's further transmission in the population.

Table 5. Fixed effects model (dependent variable: Log (Mortality Rate))

Variable	Estimate	Std. Error	Wald test
Antiretroviral therapy	-0.50	0.16	**
(Antiretroviral therapy)^2	-1.31	0.16	***
Government Expenditure	-10.74	3.60	**
(Government Expenditure)^2	112.65	35.32	**
Health Expenditure	-13.64	2.90	***
(Health Expenditure)^2	110.18	19.90	***
Prevalence of HIV	9.83	1.37	***
Access to at least basic drinking water services	-5.91	0.65	***
(Access to at least basic drinking water services)^2	4.95	0.49	***
The Logarithm of Life Expectancy	-1.30	0.22	***
Urban population	0.53	0.42	-
The Logarithm of Adolescent fertility rate	-0.60	0.08	***
The Logarithm of GDP per capita	0.07	0.07	-
Observations		1339	
R-squared		0.28183	
Adjusted R-squared		0.21366	

Note: "-" p < 1, "." p < 0.10, "*" p < 0.05, "**" p < 0.01, "***" p < 0.001.

The increase in the Government Expenditure as a share of GDP by 1 p. p. is associated with the decrease in the virus's Mortality rate by 0.47 % on average among the countries. The result is supported by the literature as financing the education sector increases people's well-being, makes them more educated. In the case of HIV/AIDS, educated people tend to make better self-heath preservation decisions and react quicker in response to getting infected by HIV.

The change by 1 p.p. in the Health Expenditures as a share of GDP is negatively associated with the change in Mortality rate by 0.13 % on average. The result is supported by the literature as increased spending on the health care system leads to its development. It increases the number of HIV tests, facilitates support programs for HIV-infected people, and induces better protection from HIV/AIDS in the long run.

To exclude the possible biasness in the coefficient estimates while choosing between fixed or random effect specifications, the Durbin-Wu-Hausman test should be performed. The test evaluates the consistency of fixed effect specification's estimators compared to random ones. As a result, it implies distinguishing which specification corresponds better to the data. The Hausman test's null hypothesis is that random effect specification is preferred. Table 6 represents the test's result.

Table 6. The Durbin-Wu-Hausman test results

Comparison of the fixed and random effect specification	
Chi-square distribution	311.64
Degrees of freedom	13
P-value	2.2e-16
Alternative hypothesis	One model is inconsistent

Since the p-value is less than 0.05, we reject the null hypothesis in favor of random effects specification. Therefore, the previous assumption about the presence of some constant unobserved heterogeneity across the countries was accurate, and the fixed-effect model specification will eliminate the possible omitted variable bias.

According to the methodology, there might be time fixed effects in the fixed effects specification; therefore, we perform a test whether the effects are needed to account for in the model.

Table 7. Breusch and Pagan test for time-fixed effects

Comparison of the fixed and random effect specification	
Chi-square distribution	2.3673
Degrees of freedom	1
P-value	0.1239
Alternative hypothesis	Significant effects

The null hypothesis of the test suggests that no time-fixed effects are needed. Since the p-value is larger than 0.05 then we fail to reject the null hypothesis; therefore, there is no need to use time-fixed effects in the model.

Chapter 6

CONCLUSIONS AND POLICY RECOMMENDATIONS

In this study, we investigate how socioeconomic conditions impact mortality from HIV/AIDS. In particular, we look at the effect of Antiretroviral therapy, Government education expenditure as a share of GDP, and Health expenditures as a share of GDP on the virus's death rate. It is crucial to get rid of the disease as approximately 38 million people had been suffering from HIV in the 2019 year.

The decrease in the virus's mortality rate and its prevalence must be assisted worldwide since the human immunodeficiency virus steadily decreases human capital. Moreover, the disease mainly targets a relatively young working-age population. As a result of the moderate and high mortality rate, there will be fewer skilled people and an overall labor force in a country.

The empirical findings suggest that an increased number of deaths from the virus decreases budget revenues, resulting in less available money to spend on government projects and services. Also, the productivity of the people living with HIV without proper treatment is constantly reduced. Overall, each country's economy with a relatively moderate and high mortality rate from HIV/AIDS suffers significantly. Consequently, it leads to a lower rate of a country's potential economic growth.

The results of the study suggest that Government expenditures on education contribute significantly to dealing with the Mortality rate. The literature supports the result since the funding of the educational sector improves their education level as well as overall well-being, which both directly and indirectly facilitates their self-health care.

Secondly, it is supported both by the literature and the study that Health expenditures have a significant negative effect on the HIV/AIDS Mortality rate. The expenditures on the health care system develop health care infrastructure. It leads to the building of more HIV-diagnose centers, which improves the number of HIV tests per annum in a country. Moreover, the increased health care system funding induces new support programs for HIV-infected people. Thereby, increasing expenditures on Health care is a prudent way to the reduction of Mortality rate from HIV/AIDS.

Thirdly, Antiretroviral therapy has a negative and significant effect on the reduction in the Mortality rate from HIV/AIDS. The research shows that the increase in therapy coverage is the most significant way to deal with the virus. The medication treatment helps to bring people's life expectancy close to a normal one. Moreover, the literature suggests that Antiretroviral therapy may significantly decrease the transmission of HIV in the population. It comes from the following factors:

- The treatment reduces the concentration of HIV RNA in an infected human's body. It lowers the chances of the virus being spread through any known transmission channel;
- The treatment might be used as pre-exposure prophylaxis (PrEP). Those people who are not infected with the virus but are at significant risk of getting HIV could prevent themselves from getting infected by undergoing a reduced version of ART treatment. Research shows that this kind of measure lowers the chance of getting infected through sexual contact by 99%. Also, PrEP minimizes the probability of HIV transmission by 74%, even for those who inject drugs. However, for pre-exposure prophylaxis to be effective, it must be taken consistently (CDC, 2020).

Overall, the increase in Antiretroviral therapy coverage is the most effective way to reduce the Mortality rate from HIV/AIDS as well as its prevalence in the short- and long run across the globe.

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