What Strategy for Optimal Health in Poorest Developing Countries

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Abstract
This article shows how the international organizations' goal i.e *zero discrimination in health care access* may lead *to zero HIV new infection and zero decease* in Africa. A macroeconomic model is used to study the achievement of this goal. Whereas the macroeconomic literature studies the impact of HIV/AIDS on the economic growth, this analysis assimilates the HIV/AIDS virus to a perfect foresight dynamics to study health alteration process. The results found are: before the "seropositivity", vaccine may be efficient. In the transition between the HIV and the AIDS thresholds, medical-care may slow death process. After the cross of the AIDS threshold, the organism converges to the dead zone. Indeed, HIV eradication needs population implication on the one hand and the cooperation between the low cost pharmaceutical companies and the poor countries government with the international organizations on the other hand.
Keywords: HIV/AIDS Threshold; HIV/AIDS; Medical-care; Dead zone

1. Introduction

The 34 millions of people who suffer from HIV/AIDS mostly live in developing countries. In 2010, the 2,7 millions new cases of infected people by the HIV virus discovered, led to 1,8 million deaths. Sub-Saharan Africa concentrates 68% of the new infections cases and represents half of the whole deaths from AIDS in the world. But if 6,6 millions of people can be attended in the world, almost 8 millions still unable to beneficiate from the HIV cares. Because, for one attended individual, it can be found two new infected cases. Indeed, without efficient prevention, the number of people in need will achieve unsustainable proportions. The World Bank supports countries for *prevention, finances HIV attendance costs* and ensures *social assistance of the HIV/AIDS consequences on families.* The British International Ministry and the World Bank cooperate in several programs like *vaccine* against HIV/AIDS in order to stop the pandemic. Moreover, at the closing ceremonies of the International AIDS Conference in Vienna in 2010, *US President Obama pledged* to "redouble efforts to fight HIV and AIDS through a Global Health Initiative".

The aim of this article is to study how the UN HIV/AIDS goal i.e *zero new infection, zero decease and zero discrimination in health care access* can be reached. The analysis models the HIV/AIDS virus dynamics in an endogenous growth model in order to contribute to the UN goal achievement.

In my previous article [Loubaki (2012a)] based on the evaluation policy proposed by Kremer-Glennerster (2004), I proved that, HIV is a dynamic process with three stages. This present work follows my previous work and examines the UN HIV/AIDS goal under the World Bank's intervention in cooperation with the British International Ministry. The results found are: HIV vaccine may be efficient at the first step when the HIV threshold is not reached yet. In the transition process between HIV and AIDS, medical-care may slow the death process. But once the AIDS threshold is crossed, the previous tools are no more efficient to fight against the virus because its power becomes too strong. The organism converges to its long run growth which is the death zone. Consequently, to eradicate the virus, population must be informed on the great risks of the virus in order to change his habits. In parallel, negotiations must be conducted between the government, International Organization and low cost pharmaceutical companies for high quality drugs distribution and prevention cost.

The effects of HIV/AIDS in growth models are explored in terms of the differences in projected annual growth rates between "with-AIDS" and "no-AIDS" scenarios. Allyn Young (2005) emphasizes reduced fertility in response to the epidemic which increases per capita consumption as well as savings and economic growth. However, Bell et al. (2003, 2004), emphasizes a large reduction in investment in the human capital (schooling) of children as a result of AIDS-related illness and mortality. The cumulative result is a large decline in GDP. Cuddington (1993a and 1993b) is a Solow-style model developed to study the effects of the AIDS epidemic on the growth path of the economy. Cuddington and Hancock (1994) generalize and extend the earlier analyses of Cuddington (1993). Now GDP per capita in a neoclassical one-sector, two-factor growth model predict economic growth in Malawi and the United Republic of Tanzania. The results are: over the period 1985-2010, GDP growth is reduced by up to 1.5 percentage points in Malawi and 1.1 percentage points in the United Republic of Tanzania. Applying an eleven-sector computable general equilibrium model to the analysis of the impact of AIDS in Cameroon, Kambou, Devarajan and Over (1992) found that over a period of five years, the loss of an urban worker had seven times the negative impact on production as would the loss of a rural workers. Over (1992) uses a model that distinguished between three classes of workers and between rural and urban production to project the macroeconomic impact of AIDS on the growth trajectories of 30 countries in sub-Saharan Africa over the period 1990-2025. The net effect of the AIDS epidemic on the annual growth rate of per capita GDP is reduced of about 0.15 percentage point on average. Theodore (2001) estimates the economic losses associate with HIV in three Caribbean countries (Jamaica, Saint Lucia and Trinidad and Tobago). He found that by 2005, HIV/AIDS will lead to a reduction of GDP by comparison with a "no-AIDS" scenario. Bonnel (2000) uses cross-national regressions to estimate relationships among economic growth, policy, institutional variables and HIV/AIDS. He estimates that, for a sub-Saharan country with HIV prevalence of 20 per cent, the annual growth rate of GDP per capita during the period 1990 to 1997 would have been 1.2 per cent higher without HIV/AIDS. A 2002 World Bank's study of the economic impact of HIV/AIDS in the Russian Federation showed that GDP in 2010 could have been up to 4 per cent lower and without intervention, the loss could rose to 10 per cent by 2020.

Consequently, whereas both theoretical and empirical macroeconomic models of HIV/AIDS look for the outcomes on growth, this analysis assimilates the HIV/AIDS virus to a perfect foresight dynamics in order to understand how to deal with economic policy in order to eradicate it. Indeed, this is a medical economic model which deals with the interaction between health state alteration of the agents due to HIV/AIDS prevalence and economic policy. The reason results from the fact that economic science has already addressed the HIV/AIDS negative impact on growth. Next section develops the model and discusses the results of the study which ends up with a conclusion.

2. The Analysis

Consider an overlapping-generation model with agents who live for a few periods of time. The economy is under developed and composed of a stock of sick people, S_t and a stock of non sick people, L_t as well as a social planner who receives funds and technical assistance from International Organizations for health recovering process. Time is normalized to unity in order to highlight agents' activities depending on their health state. Non sick people spend their whole time to production whereas sick people cannot because they must share their time between the medical assistance sector to be attended and to the good production to live.

The supply side has a 2X2 structure, one production sector which manufactures one homogenous consumption good as well as one medical sector which provides health-care to sick people. Non sick people have also a medical-care provided by their net wage rate income.

2.1 The Good Production Sector

The final good production sector utilizes non sick people L_t as well as sick people S_t to produce goods according to the production function, Y_t i:e

$$Y_t = \delta(uS_t)^{\beta} L_t^{1-\beta} \qquad (1)$$

Where u is the average time spent by a sick people in good production process, $0<u<1$, β is the elasticity of the sick agents and $1-\beta$ is the elasticity of the healthy agents in the production sector.

The production function can be written in intensive form such as:

$$y_t = \delta k_t^{\beta} \qquad (2)$$

Where $k_t = uS_t / L_t$ and $y_t = Y_t / L_t$

The workers are remunerated at their marginal productivity i.e

$$w_t^S = \delta \beta k_t^{\beta-1} \qquad (3)$$

$$w_t^L = \delta(1-\beta) k_t^{\beta} \qquad (4)$$

2.2 The Medical Sector description

At time *t*, the medical sector of the developing country contributes to health-care according to medical technology, A_t given to them by international organizations, employs a stock of medical staff P_t as well as a stock of sick patients, S_t which is the sum of two kinds of individuals infected by the same virus. Sick people are distinguished according to the state of the development of the HIV virus. Meaning that, sick people can be at the HIV illness state denoted by S_t^{HIV} or at the AIDS illness state denoted by S_t^{AIDS} such that

$$S_t = S_t^{HIV} + S_t^{AIDS} \qquad (5)$$

The S_t^{AIDS} agent's health state is worse than the health state of the S_t^{HIV} agents. The health state differentials lead to technology differentials in medical-care. Medical technology used by the staff is a sum of precaution tools and medical assistance i.e

$$A_t = A_t^{HIV} + A_t^{AIDS} \qquad (6)$$

2.3 The social planner intervention

At time *t*, both the staff and the sick people stocks, enter together in the medical sector at an exogenously specified staff-sick people ratio $\gamma>1$ such that $\gamma P_t^i = S_t^i$. The sick people medical-care cost z_t is supported by *per-capita* international aid, a_t as well as fiscal policy on worker's wage rate income, τ such that $z_t = \frac{w_t^P}{\gamma}$ where w_t^P is the wage rate income paid to the medical staff. Therefore, the budget constraint of the social planner is $a_t + \tau\left(w_t^S + w_t^L\right) = \gamma z_t$. Indeed, *per-capita* tax rate is expressed by equation (7) i.e

$$\tau = \frac{\gamma z_t - a_t}{\delta\left[\beta k_t^{\beta-1} + (1-\beta)k_t^{\beta}\right]} \qquad (7)$$

2.4 The Medical sector production function

The medical production sector utilizes medical staff as well as medical equipment to treat HIV/AIDS sickness according to the following production function:

$$Y_t^M = \delta_M P_t \left[A_t^{HIV}(1-u)S_t^{HIV}\right]^{1-\alpha}\left[A_t^{AIDS}(1-u)S_t^{AIDS}\right]^{\alpha} \qquad (8)$$

Where (1-*u*) is time spent by sick agents at the hospital. The production function (8) can be written in intensive form such as, (9) i.e

$$y_t^M = \delta_M h_t^{\alpha} \qquad (9)$$

In the long run, population increases only according to healthy agents' growth rate because after the HIV step, it is the AIDS step. The last step after the AIDS step is the dead zone which takes sick people away from the economic system in each time along the period. Equations (6)-(9) stipulate several things: *first* medical technology given to sick agents is relates to their health degradation. *Second,* an agent who suffers from HIV or from AIDS is not healed using the same technology. *Third,* the damages caused by the HIV virus necessitate the use of different strategies to fight against it.

2.5 The Utility Function

The utility function of the agent depends on *per-capita* consumption, c_t as well as on *per-capita* HIV vaccine, v_t given to him by the social planner and received from World health organization. The utility function of the agent may be hurt by HIV expressed by the variable, b_t i.e

$$U(c_t, v_t) = \ln(c_t) + \theta \ln(v_t) - \pi \ln(b_t) \tag{11}$$

Where $0<\pi<1$ and $0<\theta<1$. The agent spends his net income on consumption and medical care i.e

$$W_t^i=(1-\tau)w_t^i=c_t^{\,i}+b_t^{\,i} \tag{12}$$

There exist $v>0$ such that $v<u$, therefore, $W_t^L>W_t^{HIV}=uW_t^S>W_t^{AIDS}=vW_t^S$

The above inequalities mean that the healthy agent wins more income than the HIV sickness agent because he works more. The HIV sickness agent wins more income than the AIDS sickness agent because he works more. Positive HIV means medical-care cost $i=S,L$.

The respective optimization program of the healthy, HIV and AIDS agents, (13), (14) and (15) are

$$X^L=\left[\ln\left(c_t^{\,L}\right)+\theta\ln(v_t)-\pi\ln\left(b_t^{\,0}\right)\right]+\lambda_L\left[W^L-c_t^{\,L}-b_t^{\,0}\right] \tag{13}$$

$$X^{HIV}=\left[\ln\left(c_t^{\,HIV}\right)+\theta\ln(v_t)-\pi\ln\left(b_t^{\,HIV}\right)\right]+\lambda_{HIV}\left[W^{HIV}-c_t^{\,HIV}-b^{HIV}\right] \tag{14}$$

$$X^{AIDS}=\left[\ln\left(c_t^{\,AIDS}\right)+\theta\ln(v_t)-\pi\ln\left(b_t^{\,AIDS}\right)\right]+\lambda_{AIDS}\left[W^{AIDS}-c_t^{\,AIDS}-b^{AIDS}\right] \tag{15}$$

The first order conditions of the optimization problems determinate HIV threshold, $b^*=b^{HIV}$, AIDS threshold, $b^{max}=b^{AIDS}$ and medical-care equilibrium cost, $m^*=b^L$. Where $|b^{Hiv}|>|b^{AIDS}|$ and then *AIDS* negative impact is higher than that of *HIV*. The parameters are expressed by equations (16), (17) and (18) i.e

$$m^* = \left(\frac{\pi}{1-\pi}\right)W^L \tag{16}$$

$$b^{HIV*} = -\left(\frac{\pi}{1-\pi}\right)W^{HIV} \tag{17}$$

$$b^{AIDS} = -\left(\frac{\pi}{1-\pi}\right)W^{AIDS} \tag{18}$$

The figure1 summarizes the HIV/AIDS evolution in the organism

3. Results and Discussions

The question on which we are attempting to answer is: how to make AIDS converge to HIV and HIV converge to healthy locus, as well as L to stay at the healthy locus?.

-L may stay at the healthy locus through vaccine on HIV.

-If it is not the case i.e the organism answers positively to HIV sickness then $bo>0$, the agent is positive on HIV, the deal is to make this agent's health dynamics go back to the healthy locus through an appropriate economic policy.

If $b_o \leq b^{HIV}$ then b_o may converges to zero through appropriate medical technology because $\gamma z_t-a_t<0$, thus $z_t<a_t/\gamma=a^*$ which means that, costs are lower than benefits. Sickness still low and without gravity and able to be financed and healed.

Otherwise, if $b_o> b^{HIV}$ then b_o converges to b^{AIDS} indeed $\gamma z_t-a_t>0$, therefore $z_t>a_t/\gamma=a^*$ which means that, costs in terms of financial support and health alteration are too high compare to benefits. Sickness gravity is higher than the threshold, thus the agent is too ill to be saved. Infected agents are too much in the hospital expressed by the level of γ, which is high and attendance expressed by a^* not efficient enough at that level. Indeed, the *HIV* dynamics converges to *AIDS* locus, because medical-care costs are too high and medical-aid not strong enough, the virus crosses the b^{AIDS} threshold. Then u converges to v which means that, the organism system converges to the dead zone.

Consequently, it is only when $\gamma z_t - a_t < 0$ which leads to $z_t < a_t/\gamma = a^*$, then vaccines returns on health is high and may prevent the virus introduction in the organism. Thus, since HIV is below the threshold i.e $b_o < b^{HIV}$, then the UN goal would be verified because, if $b_o \rightarrow 0$ then the virus died because at that state, prevention may work and keeps the agent away from death. Otherwise, if $b_o \rightarrow b^{HIV}$, then the agent is infected but the virus is not strong yet. Therefore, medical-care may make the agent stay healthy and prevent his organism to converge to b^{AIDS}.

To stop the virus propagation in the organism in the case where $b^{HIV} \leq b^{AIDS}$ i.e HIV virus is in the organism and tends to AIDS. For $b^{HIV} \rightarrow b^{AIDS}$ the virus needs more power to lead the health dynamics to the dead zone. Thus, its velocity convergence must be slowed in order to prevent it to reach the AIDS state. In this present case where the organism faces $\gamma z_t - a_t = 0$ because $b^{HIV} \leq b^{AIDS}$ which means, HIV medical technology tools are able to stabilize the virus and protect the organism from the raising forces of the virus. Since the HIV dynamics velocity is equal to zero or net benefits equal to net cost, then life expectancy may be increased. For that to hold, there must not be barriers in health care access.

Consequently, keys to understand the HIV law of motion in order to stop it economically, are *first* to locate it according to its scale evolution in order to know how to act i.e is it prevention, precaution or too advanced and thus medical-care is the most appropriate?. Meaning that, population must be informed on the economic gravity of this phenomenon and leave risky behaviors in order to prevent the virus to alter health. *Second*, to collect the information on the previous responses in order to constitute a data panel which highlights needs on appropriate remedies to propose in order to fight the virus *Third*, on the basis of the information collected earlier, to organize health-care distribution after the discussions of the government with international funds and low cost pharmaceutical drugs companies.

Finally, HIV infection main fight strategy is the implication of the agents in the desire to stay healthy through the information on the danger aspect of the virus.

4. Conclusion

This article generalizes and extends my previous work, it establishes an environment which incorporates all the actions done by the international organisms such as the World Bank in order to look for one best way to accomplish the UN HIV/AIDS goal. We use the several stages dynamic process concept previously proved (in my previous article) to describe HIV sickness over time in order to precise the appropriate economic policy to conduct. The HIV/AIDS thresholds allow for sickness control possibility and data collection for health policy management. Finally, the UN HIV/AIDS goal achievement necessary conditions are:

-To declare HIV danger and obtain a report on the effective situation expressed like data information on a public health emergency. Then, to look for population cooperation (information step) in order to change risky behaviors (precaution step) for sustainable life preference which are crucial because vaccine is not available.

-To negotiate with research pharmaceutical companies that manufacture anti-retroviral drugs to seek quality life saving therapies at the cheapest possible price. (Medical-care step). At that step, the tools control impact depends on the thresholds established in the model which predict death occurrence time.

-After the implication of population and low cost pharmaceutical companies as well as the government in the inquiry, then the implication of the donors would be cost less and profitable for sustainability.

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Notes

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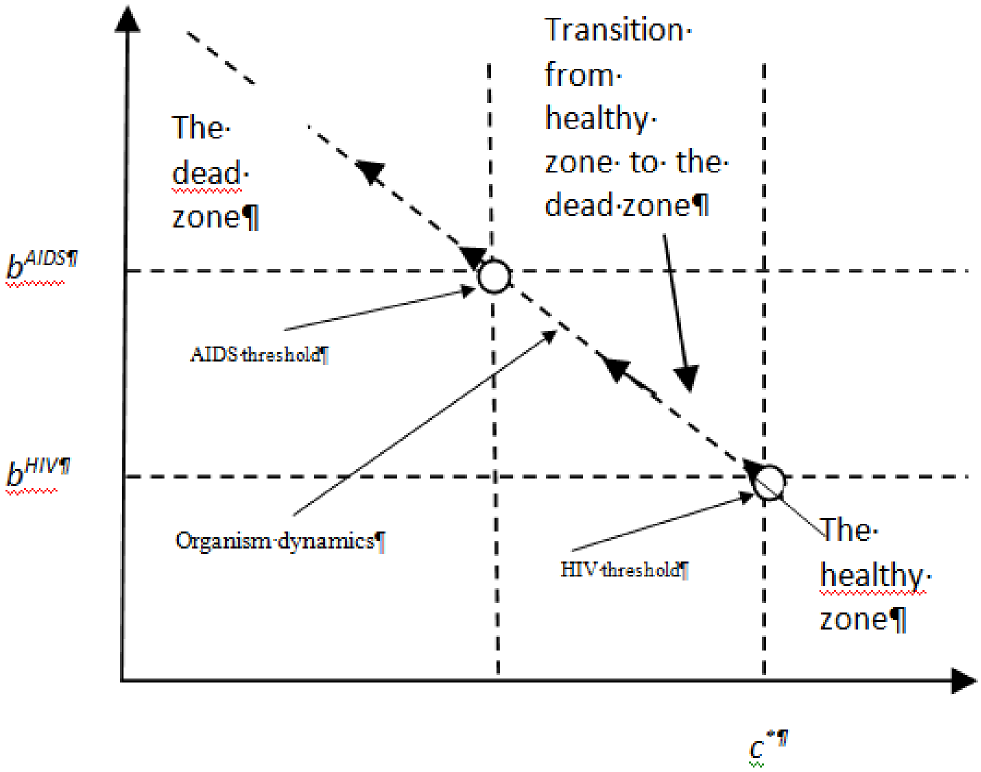

Figure 1. The description of the HIV/AIDS dynamics