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OPTIMAL GROWTH WITH HIV/AIDS AND FOOD CRISIS IN SUB-SAHARAN AFRICA

Diana Loubaki[1]

ABSTRACT

UN millennium development goal i.e the reduction of half the proportion of people suffering from hunger by 2015 can't be achieved without introducing HIV/AIDS eradication for food security to increase in Sub-Saharan Africa where deaths from HIV/AIDS reaches 68% of the whole world. This article looks for growth occurrences in Africa where development crisis means both food shortages and HIV/AIDS prevalence, it investigates the impact of HIV/AIDS in the difficulties faced by SSA countries to respond to food crisis and shows off the existence of a health-care/food need stable equilibrium able to improve sustainability and economic development.

Key Words: HIV/AIDS, Sustainability, Food crisis, SSA, Poverty, Under development

INTRODUCTION

This article investigates the economic situation in Sub-Saharan Africa where prevail under development defined by the link between food shortages and the relationship between HIV/AIDS prevalence to health-care system absence. *The purpose is to determinate if the persistency of the actual food crisis began in 2008 can be explained by HIV/AIDS prevalence*. In 2005, among the 38.6 million people living with HIV/AIDS, 63% were in SSA. Poverty increases vulnerability to risk of infection due to more risky behaviors such as transactional sex and the negative impact of the disease on human organism. HIV/AIDS mainly affects economically active adults and contributes to worsen and to widespread food insecurity by reducing the capacity of households to work, to produce or to buy food. Therefore it reduces social support mechanics [UK Parliament POST note 210]. *The second aim of the article is to establish allocation criteria in food and health-care received from donors and given both to HIV/AIDS sick people and to healthy people in order to identify needs and emergencies families for a better link of economy and sustainability*. Food

[1] IRES, Université Catholique de Louvain 1348, Louvain-la-Neuve, Belgique **E-mail:** diana.loubaki@laposte.net

security and insecurity are terms used to describe whether or not people have access to sufficient quality and quantity of food. Improved food security is important for global reduction of hunger and poverty in economic development target. *The UN millennium development goal is to reduce by half the proportion of people suffering from hunger by 2015*. Currently, 820 million people are affected by hunger in developing countries and numbers are not falling quickly enough to achieve the goal, particularly in Africa and Southern Asia.[UK Parliament Office of Science and Technology **December 2006** Number 274].

In order to treat the above questions, the analysis shows that health cost dynamics constraint food shortages evolution which is links to economic growth. Development may occur only if health-care is provided in a sufficient need for food production to jump and development to take-off and improve sustainability. Then we look for the existence of the equilibrium in health-care and food needs according to the income of the agents. The equilibrium exist and it is stable which means that optimal allocation is able to improve development and sustainability.

The model follows the literatures of endogenous growth with HIV/AIDS and the literature of Food. On the one hand, most of food models' aim is the projection and the prediction of global food security. Those models focus on the future demand for food, supply and variables related to the food system at different levels. The methodology used is controlled purely by data and don't give insights into the causal relationships in the system [Diakosavvas and Green (1998), Coxhead (2000), Mohanty and Peterson (2005), Rosegrant et, al. (2005), Holden et, al. (2005), USDA (2006), Ianchovichina et, al. (2001)]. The evolution of FS approaches has basically followed three phases. The first took place as a dominant theoretical explanatory framework for food crises since the time of Malthus (the late eighteenth century) until the year 80, what Sen (1981:57) called the FAD approach, Food Availability Decline. This approach conceived famine as shortages of food supplies per capita, motivated by natural factors; e.g., drought, floods and other calamities that undermine crops or demographic factors i.e. vegetative growth that goes beyond the supply [Hewitt de Alcantara (1993)]. The second approach claimed that hunger and famine don't necessarily evolve from lack of food supplies in the market, but lack of resources in sectors to produce or purchase them. This approach focuses on the family rather than the country, but shortly after introducing the term individual, focuses not only on the availability but on the access to food as determined by vulnerable socio-economic degrees [Sahn (1989); Swift (1989); Frakenberger and Goldstein (1990), (Perez A, 1996).]. Schneider[a] et al (2011) examine global food production development until 2030 with a partial equilibrium model of agriculture and forestry including population growth, technical change, and two alternative deforestation policies. They found that food prices, per capita consumption of food, and the ratio between plant and animal food change relatively little across scenarios. The third approach focuses on individual perspective. A person enjoys food security when his consumption is always greater than his needs thus defines physiological needs [MacCalla and Revoredo (2001)]. On the other hand, the macroeconomics effects of HIV/AIDS on growth can be summarized in two approaches, the 'first approach[2] doesn't incorporate the effects of ARV (anti retroviral drugs) provision on life expectancy studies. Those macroeconomic models show little decrease of HIV/AIDS impact on growth [Cuddington (1993a and 1993b), Kambou, Devarajan and Over (1992), Theodore (2001), Bonnel (2000)] or even an increase in *per capita* GDP growth because HIV-related declines in GDP are offset by increased mortality and population decline [Young (2005)]. The second approach incorporates the effects of ARV provision on life expectancy and emphasizes different mechanics, that of reduced fertility in response to the epidemic [Haaker (2004), Arndt (2006), Marins et al. (2003)]. However, the main problem with efforts to model the macroeconomic effects of HIV/AIDS in Africa is that projections hinge crucially on assumptions made about micro-level behavioral responses of individuals which leads to the tendency of micro studies of HIV/AIDS mostly provided and of course not presented in the case of our study [Bachmann and Booysen (2003, 2004), Bechu (1998), Bollinger et al. (1999), Gregson et al. (2006b), Menon et al. (1998), Ngalula et al. (2002), Over et al. (1996), and Steinberg et al. (2002).].

The article is organized as follows, section 2 introduces and setup the model, section 3 discusses the results and finally, section 4 concludes the analysis.

The Model

Consider an overlapping-generation economy composed of two production sectors where agents live two 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 both for health recovering process as well as for food support to the population which size, N_t moves in a constant way over time, n such that $N_{t+1} =(1+n)N_t$. 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 country is facing food shortages that it is unable to protect population against death due to food shortages and HIV/AIDS virus. Sick people occasioned a direct cost $z_t=w_t^M/\gamma$ supported by international donors funds to remunerate M_t staffs (are among healthy agents). The sick agent stock S_t spend u of their time in the medical sector where they are attended and enter with medical staff at an exogenously specified ratio $\gamma>1$ such that $\gamma M_t= S_t$.

Sick people spend their remaining time, $1-u$ in the production process. The good production sector function is expressed by equation (1) i.e

$$Y_t = \mu\left[(1-u)S_t\right]^{\alpha} L_t^{1-\alpha} \qquad (1)$$

Where $\mu>0$ is the productivity parameter of good production sector and α, $1-\alpha$ are the respective elasticities of sick people and healthy people in the production of goods. Rewriting the good production function in intensive form, it yields

$$y_t = \mu h_t^{\alpha} \tag{2}$$

Where $h_t = [(1-u)S_t]/L_t$

The workers are remunerated at their marginal productivity, therefore the respective wage rate income of sick people and healthy people are

$$w_t^S = \mu \alpha h_t^{\alpha-1} \tag{3}$$

$$w_t^L = \mu(1-\alpha)h_t^{\alpha} \tag{4}$$

The medical production function employs M_t staffs and sick people such that

$$Y_t = \mu^M [uS_t]^{\beta} M_t^{1-\beta} \tag{5}$$

Where μ^M is the positive productivity parameter of the medical sector and β, $1-\beta$ are the respective elasticities of sick people and medical staffs. The medical production function can be written in intensive form such that:

$$y_t^M = \mu^M h_t^{M\beta} \tag{6}$$

The wage rate income of staff is expressed such that

$$w_t^M = \mu^M (1-\beta) h_t^{M\beta} \tag{7}$$

According to the definition, the staff wage rate income equals $z_t = w_t^M/\gamma$ therefore, the market factor equilibrium, requires the wage rate income of the medical staff to equal the wage rate income of the healthy people such that

$$w_t^L = w_t^M \tag{8}$$

Solving the above equality identifies h^M in function of h i.e $h_t^M = \left[\frac{\mu(1-\alpha)}{\mu^M(1-\beta)}\right]^{1/\beta} h_t^{\alpha/\beta}$,

introducing the expression found in the cost function links health cost to factors intensity such that:

$h_t = \left[\frac{\gamma}{\mu(1-\alpha)}\right]^{1/\alpha} z_t^{1/\alpha}$, replacing that expression in the sick people wage rate income leads to

$w_t^S = \mu\alpha\left[\frac{\gamma}{\mu(1-\alpha)}\right]^{\alpha-1/\alpha} z_t^{\alpha-1/\alpha}$ i.e we link all per-capita incomes among them which establishes one expression of incomes in function of health-care cost. Knowing that, the sick agent spends his whole income in food, a_t yields $w_t^{\ S} = a_t$.

The inter temporal utility function of the agent is expressed by equation (9) i.e

$$U(a_t, a_{t+1}) = \ln(a_t) + b\ln(a_{t+1}) \tag{9}$$

Today, we can evaluate the wage rate as well as his food consumption of tomorrow by the expression

$$w_{t+1}^{\ S} / \rho = a_{t+1}/\rho$$

Where $\rho>1$ is money depreciation rate and thus the inter temporal budget constraint of the agent is

$$w_{t+1}^{\ S} / \rho - w_t^{\ S} = a_{t+1}/\rho - \mathrm{a_t}$$

RESULTS AND DISCUSSIONS

Proposition 1:

The economic growth is linked to HIV/AIDS health-care cost and to food crisis. i.e

$$g = \varphi z^{\alpha-1/\alpha} \qquad (10))$$

Proof

The optimal program of the agent determinate the first order conditions which are $\rho b a_t = a_{t+1}$ and

$$W^S = w_{t+1}^{\ S} / \rho - w_t^{\ S} = (b-1)a_{\mathrm{t}} \ , \ \rho b\left[w_{t+1}^{\ S} / \rho - w_t^{\ S}\right] = (b-1)a_{\mathrm{t+1}}$$

Food evolution or economic growth is expressed by

$a_{t+1} - a_t = g = [(\rho b-1)/(b-1)]W^S$ assuming that $w_{t+1}^{\ S} = w_t^{\ S} = w^S$

Then the economic growth is linked to health-care cost such that $g = \varphi z^{\alpha-1/\alpha}$

Where $\varphi = \left(\dfrac{\rho b-1}{b-1}\right)\left(\dfrac{1-\rho}{\rho}\right)\left[\mu\alpha\left(\dfrac{\gamma}{\mu(1-\alpha)}\right)^{\alpha-1/\alpha}\right]$

The economic growth is constraint by HIV/AIDS prevalence through health-care cost and food shortages. Therefore the HIV/AIDS pandemic may partly explain difficulties faced by poor economies to overcome current observed food crisis. Growth is strongly linked to health-care cost, which doesn't allow economic dynamic increase. Labor productivity is reduced by the conjunction of bad health state and food unavailability. Solving hunger needs health improve first or at the same time.

The economic growth rate is currently zero, indeed the economic growth can be greater than zero only if investments on health keeps growing in order to increase labor productivity and both production and medical sectors productivities to compensate losses due to negative effects of HIV/AIDS on food production capability as well as on the nation wealth creation.

Finally, health matters can't allow the poor country develops self food sufficiency to overcome hunger. Resources are constraint by food shortages and HIV/AIDS human organism vulnerability.

Consequently, it must be established an optimal allocation of food and health-care or drugs received from international donors in order to achieve pareto optimality in growth and development for poverty to decrease. Consequently, we look for existence and stability of the *equilibrium of food* and health care allocation resources received from international donors and given to the population in order to establish growth and development sustainability improvements criteria.

Proposition2:

given food and health-care foreign aids, there exist a unique equilibrium allocation which ensures optimal growth and sustainability in the poor economy

Proof: population size at each period t is N_t and food stock received from international donors is A_F , medical assistance received is denoted A_H . Therefore per-capita food and drugs are respectively expressed by $a_F=A_F/N_t$ and $a_H=A_H/N_t$. For the economy to be more efficient, allocation must be done in a precise way according to the needs i.e assuming sick people growth rate to equal, n^S whereas healthy people evolution to equal n^L then if $n^S = n^L$ the allocation is balanced i.e $n^S= a_H$ and $n^S= a_F$. Otherwise if $n^S> n^L$ the allocation is unbalanced i.e there exist $\tau>0$ *such that* $n^S= (1+\tau)a_H$ and $n^S= (1+\tau)a_F$. Finally if $n^S < n^L$ the allocation is unbalanced i.e $n^S<(1-\tau)a_H$ and $n^S< (1-\tau)a_F$. The following array summarizes the strategy proposed.

	$(1+\tau)a_F$	$(1-\tau)a_F$	a_F
$(1+\tau)a_H$	$(1+\tau)a_F(1+\tau)a_H$	$(1-\tau)a_F(1+\tau)a_H$	$(1+\tau)a_Ha_F$
$(1-\tau)a_H$	$(1+\tau)a_F(1-\tau)a_H$	$(1-\tau)a_F(1-\tau)a_H$	$(1-\tau)a_Ha_F$
a_H	$(1+\tau)a_Fa_H$	$(1-\tau)a_Fa_H$	a_Ha_F

There thus exists a (3, 3) matrix A such that

$$\begin{pmatrix} (1+\tau)^2 & (1+\tau)(1-\tau) & (1+\tau) \\ (1+\tau)(1-\tau) & (1-\tau)^2 & (1-\tau) \\ (1+\tau) & (1-\tau) & 1 \end{pmatrix} = A$$

The characteristic polynomial of the matrix $P(\lambda)=\lambda\lfloor\lambda^2-\lambda\varphi_2+\varphi_1\rfloor$ admits 3 eigenvalues which are: $\lambda_1=0$, $\lambda_2=\frac{\varphi_2+(\varphi_2{}^2-4\varphi_1)^{1/2}}{2}>0$ and $\lambda_3=\frac{\varphi_2-(\varphi_2{}^2-4\varphi_1)^{1/2}}{2}>0$

Where $\varphi_1=(1-\tau)(1+\tau)^2+(1+\tau)^4$ and $\varphi_2=1+(1-\tau)^2+(1+\tau)^2$,

The allocation equilibrium $(a_H, a_F)^*$ exists. Indeed, because the sum of the eigenvalues is positive and the product of the eigenvalues is zero, the allocation equilibrium solution, $(a_H, a_F)^*$ is unique. Consequently, the unique stable resources allocation which ensures stability of food and health care provisions able to maintain development and sustainability improvements exists.

CONCLUSION

The models had shown that, actual food crisis bad response is influenced by HIV/AIDS prevalence which reduces human resources and capability to create the wealth of the nation. Therefore HIV/AIDS pandemic constraints economic dynamics, whereas in parallel International Organizations claim the legitimacy to fight the pandemic for optimal growth and sustainable development to be achieved. The key remains on gathering the issues on one unique goal with a better allocation of the funds received and given to population. The model shows the existence of a stable solution leading both to food shortages cease as well as to HIV/AIDS stability since resources allocations are pareto optimal and the UN goal will progressively be reached.

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