Economic Modelling 33 (2013) 471–481

Contents lists available at SciVerse ScienceDirect

Economic Modelling

journal homepage: www.elsevier.com/locate/ecmod

Economic growth and disease in the OLG model: The HIV/AIDS case ☆,☆☆

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ARTICLE INFO

Article history:
Accepted 22 April 2013

JEL classification:
I10
I12
I18
O41

Keywords:
Infectious disease
Health investment
Overlapping generations model
Economic growth

ABSTRACT

The aim of this paper is to provide an analysis of the impact of investment in health-policies on economic development. In order to do this, it is vital to bear in mind the fact that long-term economic growth is characterized by the interaction between the physical aspects of capital dynamics and the disease level in a developing country which lacks a financial market. The OLG model will be used in our analysis. Notice that the level of investment in health policies and disease management are one of the key variables of the model. It is, therefore, interesting to observe that an increase in capital may have either a direct or indirect impact on the stationary disease level and lead to effective prevention and disease control.

1. Introduction

A study carried out by the World Health Organization in 2001, clearly demonstrated that AIDS, malaria, and tuberculosis are diseases with the highest mortality rates. In the year 2000 alone, these diseases were responsible for more than 6 million deaths. Since 1981, the devastating ravage of Immunodeficiency Syndrome (HIV/AIDS), one of history's most deadly pandemics, has caused the deaths of more than 25 million people. If we focus our attention, merely, upon the dramatic consequences of these three highly-infectious diseases, it can be clearly observed that they have affected entire regions and countries. According to the UNAIDS and WHO's report (2008) the pandemic is still progressing at an alarming rate: "The number of people living with HIV worldwide continued to grow in 2008, reaching an estimated 33.4 million [31.1 million–35.8 million]. The total number of people living with the virus in 2008 was more than 20% higher than the number in 2000, and the prevalence was roughly threefold higher than in 1990.", p.7. Effectively, since the beginning of the epidemic, nearly 60 million people have contracted HIV/AIDS, and 25 millions of those have perished. Recent epidemiological trends (UNAIDS Global Report, 2012) would seem to suggest that Sub-Saharan Africa suffers most of the disease burden. Representing over 2/3 (69%) of all people living with HIV and nearly 3/4 (70%) of AIDS-related deaths in 2011, Sub-Saharan Africa remains the hardest-hit region on a global level. In 2011, an estimated 1.8 million people living in this region while the number of people acquiring HIV infection in 2001 was equal to 2.4 million. Over 14 million children lost either one parent or became orphans due to AIDS-related mortality in each of the countries where HIV was present in more than 10% of the adult population. With 26% of the adult population affected by AIDS, Swaziland is the most severely affected country worldwide (UNAIDS, 2012). Economic underdevelopment is also a determining factor and largely responsible for the ravaging effects of the epidemic (e.g. The World Health Report, 2008).

The very nature, widespread transmission and long-lasting effects of this disease account for the negative economic repercussions. From micro-economic viewpoint, Sachs (2005), noted that the destruction which HIV/AIDS causes in society can be compared to the ravages it causes in the human organism. It attacks the core of society as a whole, affecting people from all social backgrounds – men, women, breadwinners – those who live and protect the entire community are severely affected. In families, the direct cost of HIV/AIDS can be measured through loss of human life and the loss of employment

☆☆ For helpful comments and suggestions we thank Ann Bailey, Cornel Oros, Robert E Rosenman, Martin Karlsson and Daniel Goyeau. The authors wish to thank the anonymous reviewer for his helpful comments. Preliminary version of this paper has been presented at the 8th European Conference on Health Economics, July 2010, Finland, the Journées Internationales du Risque, mai 2011, IRIAF, Niort, the Insurance Inequality Health, Darmstadt 2011, Germany, the HESG Prifysgol Bangor University and Welsh Health Economics Group 2011 summer conference, Gwynedd, UK, and the 8th World Congress on Health Economics, July 2011, Toronto, Canada.

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http://dx.doi.org/10.1016/j.econmod.2013.04.033

due to the deadly implications of the disease. Needless to say, the very fact that Aids eradicates both individuals and families implies that it will also have dreadful repercussions on the nation's economy. Effective prevention and disease control, at an individual level is essential in halting and reversing the spread of HIV/AIDS. Prevention efforts would appear to be hampered since HIV/AIDS alters the agent's future expectations. An increased mortality rate, and a decline in life expectancy do not encourage investment and savings in the most heavily affected countries. From an overall point of view, HIV/AIDS can lead to reduced economic growth. According to Bonnel (2000), the causality between economic growth and disease is complex: "As shown by the previous system of equations the relations between HIV/AIDS and economic development are complex, particularly because of reverse causality. While HIV/AIDS reduces economic growth, economic growth can increase or decrease the spread of the HIV epidemic. On one hand, economic development can slow down the spread of the HIV epidemic. On the other hand, the process of economic development can facilitate the spread of the HIV epidemic." p.4. Governments of developing countries are responding with large-scale preventive measures in the field of healthcare and disease management to protect future generations and ensure stable economic growth. Indeed, the Government may modify the intertemporal allocation of resources. Thus pensions are funded directly by the savings, or by the Government who imposes transfers between generations indirectly.

More recently, the overlapping generations model has a new field of application in the field of health economics. This model is particularly adapted in the study of consequences of the economic policy on the evolution of the economy. Also this setup allows us to examine in depth the allocation of resources between generations. With the assumption of uncertain life expectancy due to an epidemiological shock, this model allows us to study the interactions between long term economic growth and disease evolution. Indeed, the economic costs of disease are considerable especially in developing countries (Bloom and Canning, 2006; Pritchett and Summers, 1996). More, on the microeconomic level, the OLG model integrates behavior and incentives of agents in terms of prevention and investment. Demographic, disease affects in particular the structure of mortality and morbidity with consequences on dimensions microeconomic and macroeconomic developments. The intensification of disease can result in a reduction of the stock of physical capital as the factory, means of transportation… To our knowledge, this choice of modeling from generations of agents incorporating a disease is especially presented by Chakraborty (2004, 2007), Momota et al. (2005) assuming that agents can be infected and die prematurely. Preventive behavior change plays an important role in reducing the prevalence of the disease. In this context, the preventive behavior of agents in the neo-classical theory is studied with the probability of survival from one period to another. The probability is determined endogenously. It depends particularly on the agent's health investment and the disease level. In the end, the dynamics of the economy is modified by the presence of the disease. Recent empirical studies highlight the complexity of the links between wealth and disease (Bloom and Canning, 2006; Pritchett and Summers, 1996). These complex interactions between the disease level and capital level[1] are examined in a simple discrete-time model. Health investment appears as a key variable synthesizing these interactions. Our objective is to investigate the long-term impact of the disease on economic equilibrium. By modeling the decisions of agents focusing on the different ways in which a disease affects an economy. So we also explore the role of variables and parameters key interactions between the disease and the economic equilibrium of long-term.

The rest of the paper will be organized as follows: in Section 2, the model and the agent's behavior will be explored, then, in Section 3, the equilibrium and the dynamics of the economy will be assessed. In Section 4, our theoretical results by numerical examples and simulations will be presented. This will, finally, bring us to the conclusion of our paper in Section 5.

2. Model: disease, consumer behavior and technology

Our analysis is based upon the overlapping generations. Agents of the same generation are assumed to be identical. They can live, at most, for two periods. Thus, the total population in any given period is composed of the young generation born during the period under consideration, $t(t \geq 0)$ and that of an older generation born at $t-1$. At the initial period ($t=0$), we must first take into account the existence of an older initial generation. In the periods to follow, the population is made up of N_t young agents born during that period and $N_{t-1} \times q_{t-1}$ older agents born at period $t-1$. They survived until period t with probability $0 < q_{t-1} < 1$, $\forall t$. Thus, the number of total population at period t is equal to $N_t + N_{t-1} \times q_{t-1}$. It can be assumed that children are protected from disease until adulthood (e.g. Chakraborty, 2004; Momota et al., 2005). Within a different framework, the very same hypothesis is outlined by Boucekkine and Laffargue (2010). It can be observed that the population of young infected agents disappears at the end of the first period. Therefore, each young agent bears $N_{t+1}/N_t = 1+n$ offspring and fertility is assumed to be exogenous, taking into account the growth rate factor $n \geq 0$. So, the inelastic labor agent supply is independent of the current disease level. Our analysis also investigates the case of LCD's (least developing countries) in which the Government sets up a public guarantee funds system in an effort to reduce endemic uncertainty (Sachs, 2005). Moreover, empirical studies conducted by WHO highlight the effects of the dysfunctions of healthcare on micro- and macro-economic level in developing countries (cf. Summers, 2005). According to the WHO (2008), this consideration explains the relevance of the intervention of the Government. It also provides a public health policy. Apart from the importance of the health system, WHO highlights the crucial role of financial and monetary institutions in the fight against disease. We know that fiscal policy can cover several objectives at the same time. In the presence of disease, the Government may seek more to regulate economic activity in modifying the tax effort. Thus, the Government can change the allocation of resources hence the consumption, health investment and the economic growth rate. Taxation then plays an essential role in the current program of fight against disease and stimulates economic development. At the beginning of a period, young agents, N_t, allocate part of their wage rate, i_t, in the public guarantee funds in order to receive income in the second period. Hence, the total contribution collected is established: $I_t = i_t \times N_t$. The Government acts as an insurance company which costs nothing, but which bears no profit. During the next period, the income from investment is equal to $R_{t+1} \times I_t$, taking into account the interest rate factor ($R_{t+1} \equiv 1 + r_{t+1}$) and r_{t+1} the market rate of return during the period $t-1$. The guarantee funds redistribute to all those who have survived from the older generation $R_{t+1} \times i_t / q_t$. It is shown that agents who survive for two periods consume all their resources.[2]

In order to improve his surviving probability, q_t, each young agent invests z_t in order to ensure good health at period t. Moreover, this probability depends also on the degree of prevalence of the disease at period t which noted X_t. Let us define X_t as disease level like Momota et al. (2005). The index summarizes all the parameters, such as the degree of insanity environment medical technology,

[1] Goenka et al. (2010) integrate an epidemiological model in a growth model on a finite horizon and continuous time. The structure of the model and its properties are very complex (bifurcation, multiple equilibria…).

[2] In this context, agents are encouraged to choose a system regulated by the Government: the actual return of the guarantee funds R_{t+1}/q_t is higher that the market's return: $R_{t+1}/q_t > R_{t+1}$.