Economic Modelling 35 (2013) 734–742

Contents lists available at ScienceDirect

Economic Modelling

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

The influence of the healthcare system on optimal economic growth

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ARTICLE INFO

Article history:
Accepted 16 August 2013

Keywords:
Healthcare system
Optimal economic growth
Healthcare sector effort function
Macroeconomic models for the healthcare sector

ABSTRACT

This paper analyzes the impact of health system in the economic growth, based upon three macroeconomic models. The first one considers the economy with only one sector, but with morbidity; in the others the economy is divided in two sectors, the productive sector and the health sector, considering it intensive in labor and after intensive in capital. The results show that the presence of the health system increases the life expectancy and the aggregate product, but does not modify the *per capita* product.

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1. Introduction

This paper presents an introductory study of the macroeconomic impacts of the inclusion of the healthcare sector in the neoclassical model of optimal economic growth.

Studies in economics regarding the healthcare sector – usually referred to as the economics of health – are well established in the literature (Arrow, 1963; Grossman, 1972). Some studies deal with the issue from a microeconomic standpoint, focusing more intensively on the public sector (Blomqvist and Léger, 2005; Østerdal, 2005; Buchumuller, 2006). Others discuss the importance of health for economic growth (Aguayo-Rico, 2005; Ainsworth and Over, 1993; Bloom and Canning, 2005; Howitt, 2005; Muskhin, 1964; Sorkin, 1997; Taylor and Hall, 1967; Winslow, 1951), but they tend to be qualitative analyses without a well-established theoretical basis, that is, a basic mathematical model. Besides, most studies deal with health in the context of the practice of healthy habits, diet, leisure, education, etc. (Schultz, 1991; Becker, 1962; Bloom et al. 2004), and not with the healthcare sector as an intermediary productive sector that deploys technology, capital, and labor with impacts in the recovery of the workforce.

In order to attempt to measure the effects of the healthcare sector on economic growth it is necessary to adequately insert such sector in a theoretical model capable of predicting the impacts caused by its presence. The empirical aspect has already been adequately addressed by Acemoglu and Johnson (2007).

Thus, the goal of the present paper is to evaluate what is the adequate policy for the allocation of resources for the optimal economic growth given the explicit presence of the healthcare sector in the economy. It also attempts to answer the question of whether there are economic advantages for society in opting for the healthcare sector in its economy.

The main contribution is to discuss the optimal economic growth in an economy not only with the existence of morbidity, but also with a healthcare sector, that needs to solve the problem of the tradeoffs between capital and labor for production versus capital and labor for the recovery of the sick or ailed workforce.

This article was divided into four sections beyond this introduction. The first one presents the model of an economy with a single sector – the productive sector – in the presence of morbidity which affects labor by reducing the workforce, that is to say, the amount of hours available for production. The second section is dedicated to the explanation and to the empirical measures of the recovery effort function, which is the function that gives the production of the healthcare sector in terms of the recovery of the hours of work available for production that were subtracted due to the existence of morbidity (representing the activity of recovering the sick or ailed workforce and returning it to the productive sector). The third one is where the economy is divided into two sectors – productive and healthcare – and where, for simplicity of analysis, two types of healthcare sector are considered, one being labor-intensive and the other capital-intensive. Finally, in the fourth section the main conclusions and some comments are presented.

2. The economy with a single sector in the presence of morbidity in labor

The model developed in this section considers a simple, closed, economy, with constant scale earnings in the production, without

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http://dx.doi.org/10.1016/j.econmod.2013.08.023

government or healthcare sector, in which the standard hypothesis of the neoclassical models is valid. The social planner's objective is:

$$\max_C \int_0^\infty U(C)e^{-\rho t}dt, \rho>0,$$

subject to

$$\begin{aligned} \dot{K} &= I = Y - C, K(0) = K_0 > 0 \\ \dot{L} &= nL - M = (n-m)L, L(0) = L_0 > 0 \\ \dot{A} &= gA \Rightarrow A = A_0 e^{gt}, A(0) = A_0 > 0 \\ Y &= F(K,L) = AK^\alpha L^\beta \end{aligned} \tag{1}$$

where $U(.)$ is the utility function, ρ is the society's impatience rate, t is the time, K is the capital, I is the investment, Y is the product of the economy, C is the consumption, L is the workforce, and all for an instant t, is omitted due to presentation issues. Also, n is the population's rate of growth, g is the technology rate growth, $M = mL$ is the morbidity, with m being the given rate of morbidity, $F(.)$ is the production function, A is the technology, α and β are the parameters of the production function, and K_0, L_0 and A_0 are the capital, labor and technology stocks that are assumed to be given.

The equations in problem (1) regarding capital, technology, and production are classic and well-established in the literature so will not be commented upon.

The equation for the movement of labor, $\dot{L}$, establishes that the rate of variation in labor is reduced as the morbidity rate grows, and grows with the growth in labor.[1] Note that one can admit the rate of variation in the workforce as, more generically, increasing with the natural growth of the population or with the recovery by the "immune system", and diminishing with the morbidity rate, that is:

$$\dot{L} = G(L) - M \tag{2}$$

where the $G(L)$ function represents the immunological recovery rate and/or the population reproduction rate.[2] To make the model simpler, it will be admitted that $G(L) = nL$, resulting in equation $\dot{L}$ of the model (1). It is considered that the morbidity is homogeneous, in other words, that it acts indiscriminately upon all people, though it is a fact that older people have a greater tendency towards ailments. This hypothesis of distinct rates of rates of affliction according to age or other population groupings shall be considered in future studies.

The utility function, as assumed by Barbier (1999), Groth (2002), and Márquez and Ruiz-Tamarit (2005), will be given by:

$$U(C) = \frac{C^{1-\varepsilon} - 1}{1-\varepsilon}. \tag{3}$$

The results of the model are classic and the deduction can be found in Appendix A. Only the morbidity is highlighted in the growth equations, without any difference from the standard neoclassical model. Eqs. (4), (5), and (6) were highlighted because they contain interpretations that are absent in the standard models.

$$\frac{\dot{\mu}}{\mu} = -\frac{\lambda}{\mu}\frac{\beta Y}{L} + m - n + \rho. \tag{4}$$

Eq. (4) represents the growth rate of the contribution of labor to the optimal social well-being, or how much one would pay to have an extra hour of work, or yet, the rate of evolution for the wages, which depends on the relative process of capital and work, and on the rates of impatience and morbidity.

In the *BGP — Balanced Growth Path*, the growth rate of the product is given by:

$$g_Y^* = (n-m) + \frac{g}{\beta}. \tag{5}$$

A sufficient condition so that $g_Y^* > 0$ is $n \geq m$. The sick people would be replaced by new births and the population would grow exponentially at the rate of $(n - m)$. If $n < m$, then the rate of technology of the productive system should withstand the reduction in the quantity of labor or in the hours available for work, and be such that $g > \beta(m - n)$.

Now, considering the rate of *per capita* consumption $c = \frac{C}{L}$, one has that:

$$g_c^* = g_C^* - g_L^* = g_Y^* - g_L^* = \frac{g}{\beta} = \frac{g}{1-\alpha}. \tag{6}$$

Therefore, g_c^* depends on the rate of technology and on the elasticity of labor (or capital), and is independent of the morbidity rate. Stiglitz (1974a,b), dealing with growth with exhaustible natural resources, found that the per capita rate of consumption converges to $\frac{\alpha_2 n + \lambda}{(1-\alpha_1)(\alpha_1+\alpha_2)}$, where λ, α_1, and α_2, represent the technological growth and the elasticities respectively. Note that, under the hypothesis of a constant return in scale and a null population growth, this is the same rate determined in Eq. (6). Thus, there is an analogy between the growth models in an economy where the morbidity is highlighted and the growth models in the presence of exhaustible resources. One observes here that the economy is viable even in the absence of the healthcare sector.

Considering the population growth rate as null, it is evident that fewer and fewer people participate in the economy and that these people will have an increasingly smaller life expectancy until exhaustion. The probability that a given generation will know the next will decrease as time goes on. One can speculate that, in this case, the quality of life is low. Such speculation is valid even for positive population growth rates.

3. The healthcare sector effort function

The introduction of the healthcare sector in the economy obliges one to deal now with two sectors: the productive sector, of end goods, and the healthcare sector, an intermediary one, which acts as a system that recovers labor that is ill.

The recovery of the health state of the workers or of the labor force has two characteristics. One is *renewable*, given by the immune system, and the other is recoverable, given by the effort in the treatment of health. In the present paper, we will deal only with the recoverable portion of this resource, so that the recovery of labor is done exclusively by means of a production effort involving capital, labor, and technology. The implicit hypothesis is that the allocation of these production factors in the effort function influences in the recovery of the workers, or of the hours of work, and that the healthcare system works so as to repair and not to prevent.

The recoverable part of the healthcare sector is, therefore, represented by a production function that depends on capital K_S, labor L_S, and technology (B), given by $Y_S = F(B,K_S,L_S,M)$, where M is the number of ill workers or the morbidity mL, a necessary input. Regardless of the

[1] It should be realized that, alternatively, any other population growth model, including: Gompertz (1825), Smith (1963), Goel, Maitra and Montroll (1971), Ayala, Ehrenfel and Gilpin(1973), all cited by Bassanezi and Jr (1998) – depending on the interest – because the factor of notice is the growth of the population and not the form of that growth; in other words: in the literature the emphasis is on the value of the growth rate and not the pattern.

[2] Elíasson and Turnosky (2004) address renewable resources by considering that the natural growth rate of the renewable resource depends on a second degree logistic function that is given by $\dot{S} = G(S) - X$, where, $G(S) = rS\left(1 - S/\bar{S}\right), r > 0$, and X is the rate of harvest. They consider that the resource is forest or fish. The source of this model is Verhulst (1838). The same function could be used here, but the choice was made to use the classic population growth function.

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