Chapter 2
Health, Lifestyle and Growth

Gianluigi Coppola

Abstract In this article, I attempt to explain why lifestyle may have a positive impact on economic growth. First, I consider the ways in which health affects a consumer's utility, and I then define a Health Production Function for which health is the output and consumer good is the input. In this approach, the Lifestyle Return to Scale (LRS) parameter is defined. The first result is that an increase in a consumer's personal income may have a positive or a negative effect on health. That is, health may be a normal or an inferior good, depending on the Lifestyle Return to Scale value. According to this result, I compute a health multiplier and then modify the Solow Growth Model in which health is labour-augmenting. The result is a model in which the Lifestyle Return to Scale positively affects per capita income and per capita income growth.

Keywords Health · Lifestyles · Growth

JEL Classification I10 · O40

2.1 Introduction

At the macro level, stylized facts indicate substantial differences in per capita income and health status among countries and regions. This may imply that low per capita incomes negatively affect health and vice versa.

G. Coppola (✉)
Dipartimento di Scienze Economiche e Statistiche,
Universita' Degli Studi Di Salerno and C.E.L.P.E, Salerno, Italy
e-mail: glcoppola@unisa.it

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In the last 20 years, the literature on economic growth has focused primarily on the role of human capital accumulation, while health has occupied only a marginal role in economic analyses. Second, if the income and health differences among countries are significant, those among regions are even stronger and are essential to economic growth.

The literature on health and health economic growth has not considered the impacts that lifestyle has on Economic Growth. The aim of this theoretical paper is to develop the relationship between Health and Growth by accounting for consumer lifestyles.

Contoyannis and Jones's hypothesis (2004) introduced a micro-model of consumer choice to define lifestyles more accurately and to explain the effects of consumers' choices on Health. At the macro level, Weil (2005) asked if the forces driving differences among regions were primarily derived from health or income. In this context, I provide an answer by computing a health multiplier (Sect. 2.2) and developing a simple modified Solow growth model in which health is labour-augmenting (Sect. 2.3). Thus, this model includes the relationship among income, lifestyle and health status first obtained at the micro level.

The first important result is that an increase in a consumer's personal income may have a positive or a negative effect on health if the consumer has a "good" or a "bad" lifestyle, respectively. At the macro level another result of the model is that lifestyle may be crucial for growth: a "good" lifestyle can generate a positive impact on economic growth, while a "bad" lifestyle may also negatively affect growth. The model also explains why health improvement positively affects income, while increasing income may have a lower effect on health (Weil 2005).

2.2 Some Empirical Evidence

The empirical evidence can be divided into two categories: Long-Run "stylized facts" and facts related to government's measures against the unhealthy habits of the citizens.

The long-run "stylized facts" show increases in per capita income and life expectancy. From 1820 to 2001, the per capita World GDP grew from $667 to $5.709 (Maddison 2003). In the same period, world life expectancy at birth increased from 28.5 years in 1820 to 65.2 years in 1990.

The differences among regions, in terms of both per capita GDP and life expectancy at birth, have also increased (Riley 2005). In 1998, the per capita GDP of the United States was 20 times that of Africa, while in 1820, it was only 3 times larger.

In the period from 1800 to 1820, the differences among regions, in terms of life expectancy at birth, were relatively low compared to the period from 1990 to 2001. In the first period, the difference between the highest and the lowest regional life expectancies was only 9.2 years. This gap widened to 26.3 years in the period from 1990 to 2001 (Riley 2005).

These disparities may be explained by differences in Public Health, Medical diagnostics and care, diet and, more generally, lifestyle.

As regards the second aspect, the government's measures, it exists a lot of evidence of the importance that people's lifestyle assumes.

For example, in England, many local governments offer incentives to encourage consumers to lead healthier lifestyles. In Dundee, smokers are offered £12.50 a week by the NHS if carbon monoxide testing shows that they have quit. In Essex, pregnant women can claim a £20 food voucher from the NHS when they stop smoking for one week, £40 after four weeks and another £40 after one year. Brighton offers children £15 to stop smoking for 28 days. Overweight patients in Kent are offered incentives for losing weight. In the US and other countries, incentives are offered for weight loss, compliance with diabetes treatments, or regularly testing negative for sexually transmitted diseases.[1]

Moreover, in Japan, a national law against obesity came into effect in 2008. Under this law companies and local governments must measure the waistlines of Japanese people between the ages of 40 and 74 during annual checkups.

In Italy, phrases warning consumers of the damage caused by smoking are printed on cigarette packs, which are sold by a state monopoly. On some packages, the following sentences appear: "Smoking while pregnant harms your baby; smoking kills".

These examples demonstrate government concern with lifestyles and the implementation of policies to change consumption habits. In so doing, many governments heavily influence individual's choices.

What determines this intrusive government interest? By reasoning backward, government interest produces a conflict between individual and social choices that originates in two factors: the rising cost of health care in many Western nations and the assumption that bad lifestyles may negatively affect labour productivity. Zargosky (2005) demonstrated a large negative association between Body Mass Index (BMI) and White females' net worth, a smaller negative association for Black women and White males and no relationship for Black males in the US. He also found that individuals who lose small amounts of weight experience small changes in their net worth, but those who lose large amounts of weight have improved financial positions.

For households in Sierra Leone, Strauss (1986) found a highly significant relationship between caloric intake and labour productivity, providing solid support for the nutrition-productivity hypothesis. The marginal effect on productivity decreases drastically as calorie consumption increases but remains positive at moderately high levels of intake. One result from this situation is a decrease in the effective price of food that is more significant for households that consume fewer calories.

In general, it can be argued that health has a positive effect on the labour productivity of individuals. Thus, lifestyle choices, such as smoking and drinking,

[1] Financial Times *Cash incentives seen as helping nation's health*, 11 April 2009.

of individuals are of interest to society and, also to firms because they affect labour productivity.

Ultimately, lifestyle choices generate externalities, a term that indicates possible conflicts that have not been resolved by the market. Externalities affect labour productivity and healthcare costs above and beyond the level for which companies are responsible. This relatively new concept of externalities is explained by Sassi and Hurst (2008):

> ………Lifestyle choices, as many other forms of consumption, may produce external effects. There are immediate externalities that derive directly from acts of lifestyle consumption, such as passive smoking, violent and disorderly behaviour associated with alcohol abuse, or traffic accidents resulting from reckless driving. There are also deferred externalities, which are generated through the link between lifestyle choices and chronic diseases. Once chronic diseases emerge, and in some cases even before they emerge (e.g., when important risk factors such as hypertension or obesity begin to manifest themselves), the individuals affected will become less productive, possibly entirely unproductive, they will make a more intensive use of medical and social services, which may be publicly funded, they may require care by members of the family and friends. Conversely, a reduced life expectancy may mean a less prolonged use of publicly funded medical and social services at the end of life, as well as reduced pension payments, which are not themselves externalities, but would translate into a less onerous fiscal burden and therefore less distortion in the way the economy works. All of these phenomena involve externalities (negative the former, positive the latter) on society at large, family and friends, which can be attributed at least to some extent to the lifestyle choices originally made by the individual. The extent to which externalities can be associated with lifestyle choices depends, of course, on the strength of the link between lifestyles and disease, i.e., by the increase in the risk of developing a chronic disease associated with adopting a particular lifestyle.

These arguments are not new. John Stuart Mill (1859) wrote the book *On Liberty* to fight against laws that would limit individual freedom. In the nineteenth century in Great Britain, social degradation phenomena such as alcoholism were prevalent. Several social movements asked the government to implement prohibitionist measures to halt these phenomena. Mill contrasted these ideas, arguing that

> what happens inside a person's body or mind is that person's private business, not the business of society and certainly not the business of the government ………over himself, over his own body and mind, the individual is sovereign.

2.3 A Micro-Model

In the following section, I define lifestyle and develop a micro-funded model that explains the relationship between health and income and the effects of income on health.

First, let us suppose that an economy produces 3 goods: 2 commodities for consumption, x and z, and Capital, K. The saving rate, s, is exogenous and constant.

According to the Grossman model (1972), health capital and the demand for health have been widely modelled in the economic literature.

Contoyannis and Jones (2004) developed a static model of lifestyle and health production. In this model, (1) income is assumed to be endogenous, but there is no direct influence of lifestyle or health on wages; (2) health affects consumer utility, unlike Grossman's dynamic model (1972) in which health is considered to be a stock that produces flows of pecuniary and non-pecuniary benefits as a result of investments; (3) health is a result of a production function in which the inputs are a vector of goods, a vector of exogenous influences on health and a vector of unobservable influences on health; and (4) the money budget constraint and the time constraint close the model. As a result of these conditions, the following are maximised: consumer utility, using a Lagrangian function, the Marshallian demand for goods and the level of consumer Health.

Contoyannis and Jones (2004) set the Health Production Function (HPF) equal to

$$H = h(C, X_U, U_H) \tag{2.1}$$

where H is a measure of individual health; C is a vector of M goods; X_U is a vector of exogenous variables that influence health; and U_H is a vector of unobservable influence on health.

In this article, the model of Contoyannis and Jones (2004) is augmented to produce a model with 2 equations: (1) the consumer utility function and (2) the health production function.

2.3.1 The Consumer Utility Function

The consumer utility function is assumed to be a Cobb Douglas function in which health, h, is an input. For this reason, health affects the consumer utility function (among others, Kip Viscussi and Evans 1990). The other 2 inputs are the commodities x and z. The utility function can be written as

$$U(h, x, z) = h^{\alpha} x^{\beta} z^{\delta} \tag{2.2}$$

Where α, β and $\delta$are the elasticities of h, x and z, respectively.

Equation $\alpha \geq 0$ may be considered as the self-assigned weight of a consumer to his/her own health. If $\alpha = 0$, health is not important to the consumer. On the contrary, if $\alpha > 0$, then health is important.

β, $\delta \lesseqgtr \mathbf{0}$. If $\beta < 0$ or $\delta < 0$, x or z is not a good but a "bad" for the consumer (Varian, 1992).

This is a static model. There is no rational addiction, but positive elasticity values indicate that a consumer knows the commodity's ophelimity.

2.3.2 The Health Production Function

Contoyannis and Jones (2004) assume that the utility of a consumer depends on a set of goods C, Health H, X_U, a vector of observable exogenous influences on U and μ_U, a vector of unobservable influences or U, defined by

$$U = u(C, H;\, X_U, \mu_U) \tag{2.3}$$

Furthermore, HPF depends on a set of goods C, a vector of observable exogenous influences on H, X_{H}, and a vector of observable exogenous influences on H, μ_H. The vector H is defined by

$$H = h(C, X_{\mathrm{H}}, \mu_H) \tag{2.4}$$

It is assumed that the consumption of a commodity can improve, worsen or have no effect on the health of a consumer. Consumption can worsen health in the case of smoking, alcohol and drugs.

For simplicity, let us assume that every commodity can only better or worsen the health of a consumer. Further, no commodities can positively impact health in small quantities and negatively impact health in stronger doses.[2] It is also assumed that x improves health, while z worsens health. The commodity x may be defined as the virtuous, or sustainable, good, and z may be defined as the harmful good.

Health also depends on the initial level of health (h_0), public health (Ψ), time t and a stochastic component ε. The Health Production Function is

$$h(x, z, h_0, \psi, t, \varepsilon) = x^{\rho} z^{-\gamma} h_0 \psi e^{\phi t} e^{\varepsilon} \tag{2.5}$$

The function can be split into two parts: $x^{\rho} z^{-\gamma}$can be interpreted as a consumer's activity, and $h_0 \psi e^{\phi t} e^{\varepsilon}$can be attributed to other factors. To simplify the model, we use the relation $\Omega = h_0 \psi e^{\phi t} e^{\varepsilon}$. The HPF is then

$$h(x, z, h_0, \psi, t, \varepsilon) = \Omega x^{\rho} z^{-\gamma} \tag{2.6}$$

In this health production function, there is one input, x, with a positive marginal productivity. This assumption is compatible with the neoclassic production function theory (Gravelle and Rees 1992). The term $(\rho - \gamma)$ is equal to the elasticity of scale and can be positive, negative or null. Let $\theta = \rho - \gamma$. Each input is

[2] The ancient Romans said "In Medio stat Virtus". In the model that hypothesis doesn't matter for each single good.

assumed to exhibit a decreasing return; thus, $0 < \rho < 1,\ 0 < \gamma < 1$, and, therefore, $-1 < \theta < 1$.

Sassi and Hurst (2008) related individual lifestyles to individual behaviours that affect health. Contoyannis and Jones (2004) also defined lifestyle "as a set of behaviours which are considered to influence health and are generally considered to involve a considerable amount of free choice".

If $\theta > 0$, consumption increases positively affect health, while for $\theta < 0$, consumption increases negatively affect health. With $\theta = 0$, consumer behaviour has no effect on health. For this reason, the parameter θ may be defined as the Lifestyle Return to Scale (hereafter LRS).

Before maximising the consumer utility function, $h(x, z, h_0, \psi, t, \varepsilon) = \Omega x^{\rho} z^{-\gamma}$ is substituted into $U(h, x, z) = h^{\alpha} x^{\beta} z^{\delta}$to yield

$$U(h, x, z) = \Omega x^{\alpha\rho} z^{-\alpha\gamma} x^{\beta} z^{\delta} \tag{2.7}$$

or

$$U(h, x, z) = \Omega x^{\alpha\rho+\beta} z^{\delta-\alpha\gamma} \tag{2.8}$$

The elasticity with respect to x becomes $a\rho + \beta$, and the elasticity with respect to z becomes $\delta - a\gamma$.

The commodity x (or z) will be consumed only if $a\rho + \beta > 0$ (or $\delta - a\gamma > 0$,) that is, if the relative elasticity is positive. The other properties of the utility function are the same as before.

Hence, the choice to consume x (or z) depends on 3 parameters: (1) the elasticity of utility with respect to x (or z) β (or δ), that is, the weight conferred by the consumer to the commodity x (or z); (2) α, the importance of health to the consumer; and (3) the benefit (or damage) of x (or z) on health β (or γ).

For example, an individual will consume a medicinal (x) only if the positive health impact $(a\rho)$ is given a value greater than the elasticity with respect to x (β). On the contrary, a consumer will not drink alcohol if alcohol is not preferred $(\delta < 0)$ or if alcohol is enjoyed $(\delta > 0)$but he assumes the negative impacts on health $(a\gamma)$ to be greater than the elasticity of alcohol's utility $(\delta - a\gamma > 0)$. A consumer may decide to drink alcohol even if the dangerous health effects are known. Further, consumers who are aware of the damage of smoking may continue to smoke.[3] Following this approach, alcohol consumption depends also on factors other than the level of a consumer's education.

Generally, by including health in the consumer utility function, the consumption of commodities that benefit health increases, while the consumption of goods that cause damage decreases because $\alpha > 0$.

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[3] See for example Berger and Leigh (1989) and Kenkel (1991) for the relationship between schooling and health. See also Avitabile (2009) for the relationship between health and information.

2.3.3 The Utility Maximization Problem: The Optimal Choice of x, z and h

Let $\Omega = 1$. The consumer's budget constraint is $p_x x + p_z z = cy$, where $p_x, p_z$are the prices of the goods; y is the per capita income used for consumption, $y = \frac{Y}{L}$; c is the average propensity to consume $(0 < c < 1)$; and L is the population. The consumer maximizes utility when $\max_{x,z} x^{\alpha\rho+\beta} z^{\delta-\alpha\gamma}$ such that $p_x x + p_z z = y$.[4] Recall that $a\rho + \beta > 0$ and $\delta - a\gamma > 0$.

Optimally solving the Lagrangian $\max_{x,z} L = U(x, z) - \lambda(p_x x + p_z z - y)$, where λ is the Langrage Multiplier, the quantities of commodities consumed are (Mas-Colell et al. 1995)

$$x = \frac{\alpha\rho + \beta}{\beta + \delta + \alpha(\rho - \gamma)} \frac{cy}{p_x} \tag{2.9}$$

$$z = \frac{\delta - \alpha\gamma}{\beta + \delta + \alpha(\rho - \gamma)} \frac{cy}{p_z} \tag{2.10}$$

The weight of health, α, increases the consumption of "virtuous" goods and reduces the consumption of harmful goods. Optimally, the health level is

$$h = \left(\frac{\alpha\rho + \beta}{\beta + \delta + \alpha(\rho - \gamma)} \frac{cy}{p_x}\right)^{\rho} \left(\frac{\delta - a\gamma}{\beta + \delta + \alpha(\rho - \gamma)} \frac{cy}{p_z}\right)^{-\gamma} \tag{2.11}$$

or

$$h = \left(\frac{\alpha\rho + \beta}{\beta + \delta + \alpha(\rho - \gamma)}\right)^{\rho} \left(\frac{\delta - \alpha\gamma}{\beta + \delta + \alpha(\rho - \gamma)}\right)^{-\gamma} \left(\frac{(p_z)^{\gamma}}{(p_x)^{\rho}}\right) (cy)^{(\rho-\gamma)} \tag{2.12}$$

Equation 2.11 is the health demand function, where $\left(\frac{\alpha\rho+\beta}{\beta+\delta+\alpha(\rho-\gamma)}\right)^{\rho}$ and $\left(\frac{\delta-\alpha\gamma}{\beta+\delta+\alpha(\rho-\gamma)}\right)^{-\gamma}$ are the shares of good x and good z, respectively, weighted for their relative health elasticities.

The level of health and the price of virtuous good are negatively correlated. If the price of good x increases (or decreases), it worsens (or improves) the level of health. Conversely, health improves (or worsens) if the price of z increases (or decreases).

The health elasticity with respect to income is $\rho - \gamma = \theta$, the parameter LRS. Unlike the parameters that can have only one sign, this parameter may be positive or negative. If $\rho - \gamma = 0$, income growth does not affect the level of health. If $\rho - \gamma < 0$, income negatively affects health. If $\rho - \gamma > 0$, income positively affects health.

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[4] This approach may be considered as a generalization of Wagstaff's model (1986). See Appendix for details.

Thus, income growth does not always positively affect health. The sign and the degree to which income affects health depend on the parameter θ.

A proxy or Index of a consumer's Lifestyle (LI) may be given by the weighted average of the quantity of commodities consumed for the consumer's health elasticity. This variable follows the relationship $-1 < LI < 1$ and is given by

$$LI = \rho\left(\frac{\alpha\rho + \beta}{\beta + \delta + \alpha(\rho - \gamma)}\right) - \gamma\left(\frac{\delta - \alpha\gamma}{\beta + \delta + \alpha(\rho - \gamma)}\right) \tag{2.13}$$

Therefore, LRS θ is a crucial variable in the model because it indicates the attitude of a consumer, based on preferences and opportunities, toward leading a particular lifestyle. Thus, $\theta = \rho - \gamma$ partially and indirectly reflects consumer preferences because the health production function contains only those commodities that consumers prefer or can purchase.[5]

2.4 Comparative Static: The Health Multiplier

In the previous section, the effects of income on health were described. Assuming the existence of a representative agent, Eq. 2.11 can be rewritten as

$$h = \upsilon\left(\frac{Y}{L}\right)^{\theta} \tag{2.14}$$

where $v = \left(\frac{\alpha\rho+\beta}{\beta+\delta+\alpha(\rho-\gamma)}\right)^{\rho}\left(\frac{\delta-\alpha\gamma}{\beta+\delta+\alpha(\rho-\gamma)}\right)^{-\gamma}\left(\frac{(p_Z)^{\gamma}}{(p_x)^{\rho}}\right)c$

A production function with a constant return to scale and for which both technology and health are labour augmenting is assumed. This may be a Cobb Douglas Production Function (i.e. Weil 2005; Sala-i-Martin 2005).

$$Y = K^{a}(AhL)^{1-a} \tag{2.15}$$

or

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[5] Three issues should be highlighted here. First, in this simple consumer model, choices are made between two commodities. In reality, a commodity may be not consumed for three reasons, the first two of which were outlined previously: (1) the consumer does not like a commodity; (2) even if a commodity is liked, the health damage caused by the commodity may be greater than the commodity's utility, preventing consumption of the commodity; and (3) the relative price of a commodity may be greater than income, preventing consumption of the commodity. In the first two cases, the commodity is not consumed as a result of free choice. In the second case, this choice may be difficult. In the third case, price and income limits restrict access to the commodity. In this article, we consider only the case in which individuals consume both commodities.

$$\frac{Y}{L} = \left(\frac{K}{L}\right)^{a} (Ah)^{1-a} \tag{2.16}$$

From the system given by Eqs. 2.14 and 2.15, the impacts of a "health shock" (Δv) and an "income shock" (ΔA) on health and income can be quantified.

Solving this system yields the effects in terms of elasticity. The results are reported in Scheme 1 for $0 < \theta < 1$.

Scheme 1

	On health	On income
	$-1 < \theta < 1$	
Health shock	$\frac{d\log h}{d\log v} = \frac{1}{1-\theta(1-\alpha)}$	$\frac{d\log Y}{d\log v} = \frac{(1-\alpha)}{1-\theta(1-\alpha)}$
Income shock	$\frac{d\log h}{d\log A} = \frac{\theta(1-\alpha)}{1-\theta(1-\alpha)}$	$\frac{d\log Y}{d\log A} = \frac{(1-\alpha)}{1-\theta(1-\alpha)}$

In terms of elasticity, the health multiplier is equal to $\frac{1}{1-\theta(1-\alpha)}$ for health and $\frac{(1-\alpha)}{1-\theta(1-\alpha)}$ for income.

For $0 < \theta < 1$, both multipliers are positive and greater than one. If a lifestyle is positive, a health shock will more strongly affect health and the growth of labour productivity.

The effect of a health shock on income depends positively on both LRS and income elasticity, with respect to labour or labour income share.

The effect of an income shock on income is equal to $\frac{\theta(1-\alpha)}{1-\theta(1-\alpha)}$, while the effect on health is equal to $\frac{(1-\alpha)}{1-\theta(1-\alpha)}$. In this case, for $0 < \theta < 1$, both effects are greater than zero.

The question of whether a health shock more strongly affects income or an income shock more strongly affects health (Weil 2004) can now be answered: both technological and health shocks produce the same effect on income. This effect is equal to $\frac{(1-\alpha)}{1-\theta(1-\alpha)}$, which is greater than $(1-\alpha)$ because $\frac{1}{1-\theta(1-\alpha)} > 1$.

A health shock has an impact on health equal to $\frac{1}{1-\theta(1-\alpha)}$, which is greater than an income shock $\frac{(1-\alpha)}{1-\theta(1-\alpha)}$ because $0 < \theta < 1$. A health shock has an impact on income equal to $\frac{(1-\alpha)}{1-\theta(1-\alpha)}$, which is greater than an income shock on health $\frac{\theta(1-\alpha)}{1-\theta(1-\alpha)}$.

The effect that a reduction of the price of commodity x has on health can be quantified. The multipliers for income and health are

$$\frac{d\log h}{d\log p_x} = \frac{d\log h}{d\log \upsilon}\frac{d\log \upsilon}{d\log p_x} = -\frac{1}{1-\theta(1-\alpha)}\rho \tag{2.17}$$

$$\frac{d\log Y}{d\log p_x} = \frac{d\log Y}{d\log \upsilon}\frac{d\log \upsilon}{d\log p_x} = -\frac{(1-\alpha)}{1-\theta(1-\alpha)}\rho \qquad (2.18)$$

The effect of a price shock for x on health is equal to $-\frac{1}{1-\theta(1-\alpha)}\rho$. It depends both on the multiplier $\frac{1}{1-\theta(1-\alpha)}$ and negatively on the parameter ρ, which is the health elasticity of x. The impact on income is $-\frac{(1-\alpha)}{1-\theta(1-\alpha)}\rho$, which is the product of the impact of the price of x on health, $-\frac{1}{1-\theta(1-\alpha)}\rho$, and the impact of health on income, $(1-\alpha)$. This impact has a negative sign because a reduction in the price of x positively affects health and income.

Scheme 2 lists these health multipliers.

Scheme 2

	On health	On income
Health shock	$\frac{dh}{dv} = \frac{1}{1-\theta(1-\alpha)}Y^{\theta}$	$\frac{dY}{dv} = \frac{(1-\alpha)}{1-\theta(1-\alpha)}\frac{Y}{\upsilon}$
Income shock	$\frac{dh}{dA} = \frac{\theta(1-\alpha)}{1-\theta(1-\alpha)}\frac{h}{A}$	$\frac{dY}{dA} = \frac{(1-\alpha)}{1-\theta(1-\alpha)}\frac{Y}{A}$

2.5 A Growth Model with Health

In the comparative static framework, the level of population is constant. In this section, I present a Growth Model that includes health as an input factor and also considers lifestyle.

Interactions between health and economic growth are complex (Morand 2005). Listing all of these interactions is beyond the scope of this paper. One of the positive effects of economic growth on health is the possibility of consuming higher quantities of better quality goods. Another consequence of economic growth is that technological progress positively impacts medical technology and care.

Therefore, health may have a positive impact on Growth through several channels. First, health may positively affect labour productivity (Marshall 2006). In Chapter V, titled “The Health and Strength of the Population”, in Book 4 of the Principles of Economy, Marshall wrote that

> strength, physical, mental and moral, are the basis of industrial efficiency, on which the production of material wealth depends; while conversely the chief importance of material wealth lies in the fact that, when wisely used, it increases the health and strength, physical, mental and moral, of the human race.

For Streeten (1994), one of the reasons for promoting human development is that a well-nourished, healthy, educated, skilled and alert labour force is the most important productive asset.

In the Neoclassic Economic Growth literature, many models consider health as a factor of growth. Lòpez-Casasnovas et al. (2005) and Rivera and Currais (1999a) used a conditional convergence regression in which the growth of per capita income is a function of steady-state determinants. Assuming that health is an important determinant of an enhanced labour force, they showed that health affects income growth both positively and significantly. In another article (Rivera and Currais 1999b), investment in health significantly explained variations in the output of human capital, even in countries with presumably high levels of health.

Heshmati (2001) extended the model of Mankiw et al. (1992) by incorporating health. The results show that Health Care Expenditures positively affect economic growth and the speed of convergence.

For Morand (2005), increasing longevity may incentivise agents to increase investments in capital and human capital and thereby reinforce economic growth.

One of the main goals of this article is to consider the effects of individual lifestyles on economic growth. Let us now consider a Solow Growth Model (Solow 1956) with a constant saving rate (s), diminishing returns of capital $(0<\alpha<1)$ and labour, Labour-augmenting technology and constant returns to scale. We assume a Cobb Douglas production function:

$$Y(t) = K(t)^{a}(A(t)L(t))^{1-a} \tag{2.19}$$

where $K(t)$, $A(t)$, $L(t)$ are capital, level of technology, and labour, respectively.

Let us assume all the hypotheses of the Solow's Growth Model.

Technological progress and the population growth rate are exogenous and constant: $\frac{d\ln A(t)}{dt} = g$; $\frac{d\ln L(t)}{dt} = n$.

Assuming that health is a labour-augmenting factor (Weil 2005; Sala-i-Martin 2005), the production function becomes

$$Y(t) = K(t)^{a}(A(t)h(t)L(t))^{1-a} \tag{2.20}$$

With

$$h = \upsilon y^{\theta} = \upsilon\left(\frac{Y}{L}\right)^{\theta} h = \upsilon Y^{\theta}L^{-\theta}, \tag{2.21}$$

this becomes

$$Y(t) = K(t)^{a}\left(A(t)\upsilon Y(t)^{\theta}L(t)^{(1-\theta)}\right)^{1-a} \tag{2.22}$$

or

$$Y(t) = K(t)^{\frac{a}{1-\theta(1-a)}}\left(A(t)\upsilon L(t)^{(1-\theta)}\right)^{\frac{1-a}{1-\theta(1-a)}} \tag{2.23}$$

Equation 2.23 can be rewritten as

$$Y(t) = K(t)^{\frac{a}{1-\theta(1-a)}} \left(A(t)^{\frac{1}{1-\theta}} \upsilon^{\frac{1}{1-\theta}} L(t) \right)^{\frac{(1-\theta)(1-a)}{1-\theta(1-a)}} \tag{2.24}$$

Equation 2.24 shows a constant return to scale because $\frac{a+(1-\theta)(1-\alpha)}{1-\theta(1-\alpha)} = 1$. Substituting $a_1 = \frac{a}{1-\theta(1-\alpha)}$ and $a_2 = \frac{(1-\theta)(1-\alpha)}{1-\theta(1-\alpha)} = 1 - a_1$ yields

$$Y(t) = K(t)^{\alpha_1} \left(A(t)^{\frac{1}{1-\theta}} \upsilon^{\frac{1}{1-\theta}} L(t) \right)^{1-a_1} \tag{2.25}$$

This is a Solow's Model, and the "new" technological rate is $\frac{d \ln A_2(t)}{dt} = \frac{d \ln A(t)^{\frac{1}{1-\theta}}}{dt} = \frac{1}{1-\theta} g$

At equilibrium, the Income growth rate and per capita income growth rate are

$$\frac{d \ln Y(t)}{dt} = \left(\frac{1}{1-\theta} \right) g + n \tag{2.26}$$

$$\frac{d \ln \frac{Y(t)}{L(t)}}{dt} = \left(\frac{1}{1-\theta} \right) g \tag{2.27}$$

The income level is

$$\frac{Y(t)}{L(t)} = (A(0)v)^{\frac{1}{1-\theta}} e^{\frac{1}{1-\theta} gt} \left[\frac{s}{\frac{g}{1-\theta} + n} \right]^{\frac{\alpha}{(1-\theta)(1-\alpha)}} \tag{2.28}$$

The Health growth and Health level are

$$\frac{d \ln h(t)}{dt} = \theta \frac{d \ln \frac{Y(t)}{L(t)}}{dt} = \theta \left(\frac{1}{1-\theta} \right) g \tag{2.29}$$

$$h(t) = \upsilon^{\frac{1}{1-\theta}} (A(0))^{\frac{\theta}{1-\theta}} e^{\frac{\theta}{1-\theta} gt} \left[\frac{s}{\frac{g}{1-\theta} + n} \right]^{\frac{\alpha\theta}{(1-\theta)(1-\alpha)}} \tag{2.30}$$

The first result is that even if the Solow model with health remains an exogenous growth model, the parameter LRS positively affects per capita income growth and the level of income per capita at the steady state.

For example, if $\theta = 0.5$, the income growth rate is equal to $2g$, while a negative LRS ($\theta < 0$) results in a per capita income growth rate that is less than that of technological progress. Thus, a "good" lifestyle can improve economic growth, while a "bad" lifestyle can slow growth.

The second result is that health increases more slowly than per capita income. Unlike economic growth, the rate of health growth may be positive, null or negative, depending on the sign of the LRS parameters. For $\theta < 0$, economic growth negatively affects health, which worsens.

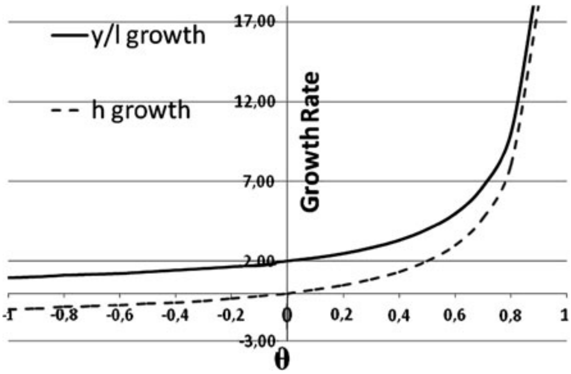

Fig. 2.1 The effect of LRS θ on the growth rate of per capita income with a constant technological growth rate ($g = 2\%$)

The second scenario may be the case of a "health-poverty trap". Such a trap was noted in Russia; male life expectancy, which can be considered a health indicator, plummeted by 7 years from 1989 to 1994 because of high levels of alcohol consumption (UNDP 2010).

The results of the model can be explained differently. Per capita income growth depends on the product of the technical progress parameter and LRS, both of which are exogenous.

Technical progress is considered to be "*manna from heaven*". In fact, the aim of the endogenous growth theory is to identify those factors and mechanisms that could be controlled by the government to ensure higher and more durable economic growth.

In the model presented in this article, another exogenous parameter, the Lifestyle Return to Scale, θ, impacts economic growth. In the introduction, we presented several cases in which governments have attempted to control lifestyles. This type of governmental behaviour has several possible explanations.

Equation 2.27 can be re-written as

$$\theta = 1 - \frac{g}{\frac{d \ln \frac{Y(t)}{L(t)}}{dt}} \tag{2.31}$$

Suppose that the government has established a target for its economic growth rate, denoted by $\hat{y}^*$, that can be controlled by technological progress g. If $\hat{y}^* > g$, the economic growth rate fixed by the government is greater than technical progress, and the government can strive for higher growth by controlling or trying to modify lifestyles, which are one of the channels that transmit the effects of economic growth to health. Conversely, if technological progress is high, lifestyles may not be important because technological progress can ensure a high level of economic growth.

Further, health growth is equal to economic growth multiplied the parameter θ. As shown in Fig. 2.1, with a fixed a technological rate g, the effects of economic growth on health improvement depend on the value of θ. Lower values of θ, result in weaker links between economic production and health improvements. This relationship could become negative for $\theta < 0$. Hence, economic growth is a necessary but not sufficient condition for improving health. If a government's priority is to improve health rather than economic growth, then LFS must be positive. In this scenario, the conflict between public and private interests can become stronger.

2.6 Conclusions

In this article, I attempted to formalize what Jean Anthelme Brillat-Savarin, the author of Philosologie of taste Brillat-Savarin 2004, wrote two hundred years ago: (1) animals feed themselves; men eat, but only wise men know the art of eating, and (2) the destiny of nations depends on the manner in which they are fed.

The crucial hypotheses of the model are that (1) individuals can rationally choose to consume goods that negatively affect health, (2) individuals are co-producers of their health and (3) health positively affects labour productivity.

First, I developed a consumer micro-model with health and two goods, both of which are positively correlated to the Consumer's Utility. Health is the output of a consumer's production function with the two commodities as inputs. The first commodity has a positive impact on health, while the second one has a negative impact.

The result is that the elasticity of consumer health with respect to income, referred to as Lifestyle Return to Scale and denoted by the parameter θ is equal to the algebraic sum of the health elasticity with respect to commodities. It may be positive, negative or neutral. In opposition to health's role as a normal good, as reported by Wagstaff (1986), health can also be an inferior good in this model.

Second, I computed health multipliers. The impacts of a health shock on health and income depend on labour share and are higher if the Lifestyle Return to Scale is positive.

Third, the micro-behaviour function was introduced in the Solow growth model in which the return to scale is constant. The most important results are that (1) Lifestyle Return to Scale affects economic growth (the growth of income per capita is higher than the technical progress if LRS is positive), and (2) health improvement depends on the parameter LRS, θ, it is lower than economic growth, and it may be negative, even if economic growth is positive. In fact, the existence of a health poverty trap in which economic growth diminishes health can be demonstrated.

In conclusion, lifestyle is another aspect of society that governments can attempt to control or regulate.For this reason, the Aristotelian concept of intermediates is useful in the definition of virtue. In Nicomachean Ethics (Aristotle 2009), Aristotle explains that

> drink or food which is above or below a certain amount destroys the health, while that which is proportionate both produces and increases and preserves it (Nicomachean Ethics, Book 2, Chap. 3).

The absence of this notion of *intermediate* in individual behaviours negatively affects society, and possible responses may be social exclusion and government interventions in the private sphere, as condemned by Mill (1859), the intensities of which may vary until an ethical Hegelian state is established.

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A.1 Appendix

A.1.1 A Generalization of Wagstaff's Model

Starting with Michael Grossman's Model (1972) and Wagstaff (1986) developed a one-period model of demand for health. The four hypotheses of the model include the following: (1) an individual's health is determined by the consumption of health inputs $h(x) = x^\rho$; (2) preferences are non-lexicographic: individuals desire health but not above everything else; (3) individuals also consume other commodities that have a positive cost for consumers, so $U = u(h, z)$ with $\frac{dU}{dh}, \frac{dU}{dz} > 0$ and $\frac{d^2U(h,z)}{dh}, \frac{d^2U(h,z)}{dz} < 0$; and (4) consumers have limited economic resources or budget constraints: $p_x x + p_z z = Y$, where p_x and p_z are the prices of commodities x and z, respectively, and Y is the income.

Assuming a Cobb Douglas Utility function and a Health production function $h(x) = x^\rho$, the Wagstaff Model can be formulated with the following formulas:

$$U(h, z) = h^\alpha z^\delta \tag{2.32}$$

$$h(x) = x^\rho \tag{2.33}$$

$$p_x x + p_z z = Y \tag{2.34}$$

where $0 < \alpha < 1$ and $0 < \delta < 1$ are the utility elasticities with respect to x and z, respectively, and $0 < \rho < 1$ is the elasticity of h with respect to x.

This is a special case of the Consumer's model (Sect. 2) with $\beta = 0$. The commodity x is not in the Consumer's utility function with $(\gamma = 0)$; thus, z does not affect health.

The solutions can be obtained from two different methods. The first was proposed by Wagstaff:

$$\max_{h,z} U(h, z) = h^\alpha z^\delta \text{ s.t. } p_x h^{-\rho} + p_z z = Y \tag{2.35}$$

In this case the Budget Constraint is not linear. The consumer chooses between health and z. The second possible solution is

$$\max_{x,z} U(x,z) = x^{\rho\alpha} z^{\delta} \text{ s.t. } p_x x + p_z z = Y \tag{2.36}$$

The consumer chooses the quantities of x and z that maximize utility.

Both methods yield the same solutions:

$$x = \frac{\alpha\rho}{\delta + \alpha\rho} \frac{Y}{p_x} \tag{2.37}$$

$$z = \frac{\delta}{\delta + \alpha\rho} \frac{Y}{p_z} \tag{2.38}$$

$$h = \left(\frac{\alpha\rho}{\delta + \alpha\rho} \frac{Y}{p_x} \right)^{\rho} \tag{2.39}$$

The main differences include the following: (1) in the Wagstaff model, Health can only be a normal good because $\frac{dh}{dy} > 0$ (conversely, in the model proposed in this paper, Health may also be an inferior good), and (2) this result depends on the lifestyle of the consumer.

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