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Sustainable Economic Development and Human Capital

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Abstract

In this theoretical paper the key role of human capital for a sustainable economic development is introduced into a simplified version of the green Solow model. The main result of this integration is the derivation of a kind of environmental Kuznets curve.

Keywords: human capital, environment and growth, sustainable development

1. Introduction

Investments in human capital are recognised as a key factor of sustainable economic development (see the very recent papers by World Bank, 2019, and Buevich et al., 2020). Indeed, empirical evidences from the EU states (Diaconu and Popescu, 2016) show the existence of a strong positive correlation among Human Sustainable Development Index (HSDI), United Nations' Human Development Index (HDI) and Human Capital Index (HCI).

In this vein, the present paper offers a theoretical contribution and introduces human capital in a simplified version of the green Solow model (Brook and Taylor, 2004). The key assumption of the model is that the higher the level of human capital in the economy, the larger the sensitivity and concern for environmental issues. Thus, more economic resources (human and physical) will be devoted to the technological progress in the environmental sector. Technological progress in the environmental sector, therefore, increases with human capital. Precisely, in the initial phase, the contribution of human capital concerns exclusively production. Subsequently, if human capital continues to increase and reaches a high level in the economy, the main benefits of a greater human capital concern economic sustainability and environmental respect. As a result, a kind of environmental Kuznets curve can be derived from the model (Note 1).

The rest of this theoretical paper is organised as follows: the next Section presents a simple economic growth model with human capital; while, Section 3 introduces the main elements of the green Solow model and derives a kind of environmental Kuznets curve. Conclusions and policy implications are also provided.

2. A Simple Economic Growth Model with Human Capital

In presence of human capital (H) as a further input, the production function of final goods and services (Y) is the following (Note 2):

$$Y = K^{\alpha} \cdot H^{(1-\alpha)} \tag{1}$$

like physical capital (K), the hypothesis of diminishing marginal returns ($0 < \alpha < 1$) prevents the infinite accumulation of human capital. Taking the natural logarithm of (1) and deriving with respect to time, we get the growth rate of the economy:

$$g_Y = \alpha \cdot g_K + (1-\alpha) \cdot g_H \tag{2}$$

Of course, the way of capital accumulation is different. As regards physical capital, we have the key equation of the Solow model (without exogenous technological progress):

$$dK/dt = s \cdot Y - \delta \cdot K$$

$$[(dK/dt) / K \equiv g_K] = s \cdot (Y / K) - \delta$$

where $0 < s < 1$ is the marginal propensity of saving ad δ is the depreciation rate of physical capital. In a balanced growth path, the constancy of Y/K implies that Y and K must grow at the same rate:

$$g_Y = g_K$$

Instead, as regards human capital, a key role is played by the investment in education (t is the time reference):

$$H = e^{(\varphi \cdot u \cdot t)}$$

$$\ln(H) = \varphi \cdot u \cdot t$$

where u is the time devoted to the investment in education and φ is the (positive) percentage change in human capital associated to a unitary increase in the time devoted to education. Thus, the growth rate of human capital is given by:

$$g_H = \varphi \cdot u$$

It follows that equation (2) becomes:

$$g_Y = \alpha \cdot g_Y + (1 - \alpha) \cdot \varphi \cdot u$$

$$= \varphi \cdot u \quad (2')$$

Equation (2’) accentuates a well-known result in growth theory: human capital is (one of) the main determinant(s) of economic growth (see, e.g., Savvides and Stengos, 2008).

3. Technology Production Function in the Environmental Sector

We start with a simple function of pollution emissions (E):

$$E = Y/A$$

Pollution emissions (E) increases with production and decreases with technological progress in the environmental sector (A). It follows that the growth rate of pollution emissions is equal to the difference between the growth rate of the economy and the growth rate of technological progress in the environmental sector, viz.:

$$g_E = g_Y - g_A \quad (3)$$

The key assumption of this model is that the higher the level of human capital in the economy, the larger the sensitivity and concern for environmental issues. Thus, more economic resources (human and physical) will be devoted to the technological progress in the environmental sector. We formalise these positive externalities of human capital on economic sustainability in a very simple way. First, we include human capital in the technology production function in the environmental sector:

$$A = A_0 \cdot H^{\beta(H)} \quad (4)$$

where A_0 is an exogenous starting value of A. Thus, the growth rate of A is given by:

$$g_A = \beta(H) \cdot g_H \quad (5)$$

Second, β(H) is not constant but varies according to the (threshold) value of human capital, viz.:

- $\beta(H) = 0$, if $H < H_{min}$, where H_{min} is the threshold value under which human capital does not generate benefits (because it is too low). Thus, in this case, technological progress in the environmental sector is exogenous and constant, i.e., $A = A_0$.
- $0 < \beta(H) < 1$, if $H_{min} < H < H_{max}$, where H_{max} is the threshold value above which human capital generates the maximum benefits. In this case, instead, technological progress in the environmental sector is an increasing and concave function of human capital (human capital exhibits diminishing marginal returns as in the production function).
- $\beta(H) > 1$, if $H \geq H_{max}$. In this case, eventually, technological progress in the environmental sector is an increasing and convex function of human capital (human capital exhibits increasing marginal returns as in the production function of aggregate economy in the presence of positive externalities of human capital).

As a result, technological progress in the environmental sector increases with human capital at increasing rates.

Introducing (5) and (2’) into (3) we get:

$$g_E = [1 - \beta(H)] \cdot \varphi \cdot u \quad (3')$$

Equation (3’) depicts a kind of environmental Kuznets curve where the main determinant of the relation between economic growth and economic sustainability is human capital (see Figure 1). In the initial phase, the contribution of human capital concerns exclusively production; thus, the growth rate of pollution increases with human capital.

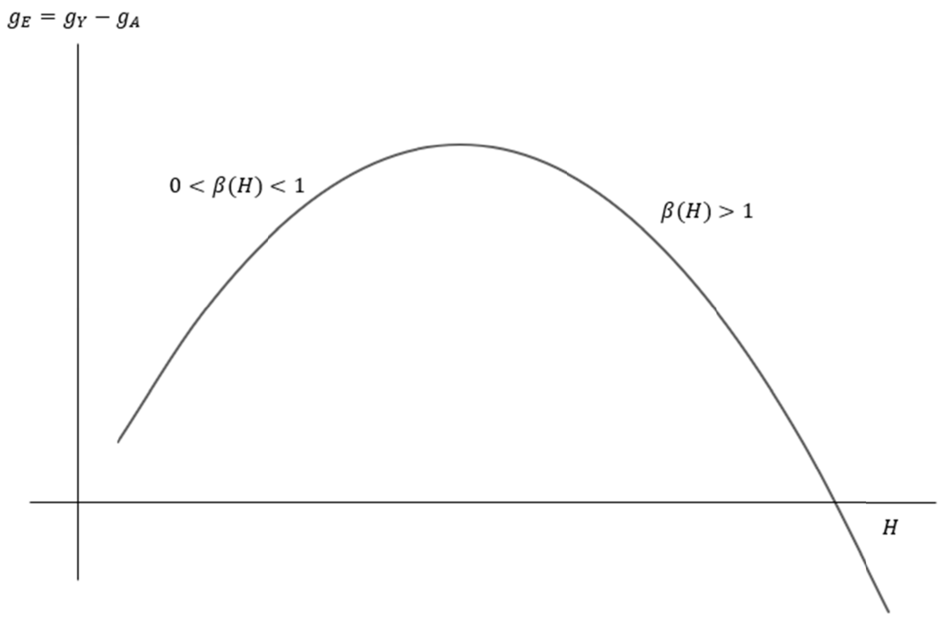

Figure 1. Environmental Kuznets curve and human capital

Subsequently, if human capital continues to increase and reaches a high level in the economy, the positive externalities related to the environmental technological progress (specifically, sensitivity and concern for environmental issues) greatly increase and, thus, the main benefits of a greater human capital concern economic sustainability and environmental respect.

This result confirms the key role for economic development of policies supporting education. Of course, this is a very optimistic view. Nevertheless, if human capital does matter in the environmental issues, the potential strong effects shown in the paper cannot be overlooked or underestimated.

4. Discussion

Nowadays, worldwide, sustainable economic development is perhaps the main issue to be addressed. Theoretically, an inverted U-shaped relation between environmental degradation and income per capita (the so-called “environmental Kuznets curve”) was hypothesised. However, empirically, the environmental Kuznets curve is not verified.

In this theoretical paper, the key role of human capital for a sustainable economic development is introduced into a simplified version of the green Solow model. Precisely, we assume that the higher the level of human capital in the economy, the larger the sensitivity and concern for environmental issues. Thus, more economic resources (human and physical) will be devoted to the technological progress in the environmental sector. We find that this reasonable hypothesis allows to derive a kind of “environmental Kuznets curve”.

Empirical correlations among Human Sustainable Development Index (HSDI), United Nations’ Human Development Index (HDI) and Human Capital Index (HCI) seem to support this theoretical (optimistic) prediction.

Economic policies supporting generic human capital are, therefore, warmly recommended.

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Notes

Note 1. The environmental Kuznets curve is named for the original Kuznets curve (1955) who hypothesised a relation first positive and then negative between income per capita and income inequality. Indeed, the environmental Kuznets curve hypotheses an inverted U-shaped relation between environmental degradation and income per capita. Precisely, in the early stages of economic development, environmental degradation (pollution) increases (at decreasing rates); while, beyond some level of income per capita, the trend reverses, i.e. high-income levels lead to a reduction of environmental degradation. In short, rather than being a threat to the environment, economic growth leads to environmental improvement. Empirically, however, the environmental Kuznets curve is not verified (for a critical review, see Stern, 2004).

Note 2. For the sake of simplicity, we assume a constant labour force, normalised to the unit ($L = 1$), so as to have equality between aggregate variables and per capita variables.