

Camilo Dagum, University of Bologna, and Giorgio Vittadini, University of Milan

Camilo Dagum, Faculty of Statistics, University of Bologna, Via Belle Arti, 41, 40126 Bologna, Italy.

KEY WORDS: Latent Variables, Wold's Method, Prospective Method, U.S. Human Capital.

## 1. INTRODUCTION

The concept of human capital has been present in the history of economic thoughts without being systematically developed within a solid theoretical framework. It becomes a main concern of economic analysis in the second half of the 20-th century with the pioneer works of Mincer (1958, 1970), Becker (1962, 1964) and Schultz (1959, 1961).

Before the middle of this century, with the exception of a few distinguished economists such as William Petty, R. Cantillon, J. von Thünen, A. Marshall, I. Fisher and J.M. Clark, who sustain the need of estimating or advancing some estimation of human capital, most economists do not go beyond the acknowledgement of the importance of skill, acquired abilities and education as sources of differential wages and salaries. Some of them go a step further, by accepting the idea that skill, acquired abilities and education contribute to determine the human capital. Others were reluctant to treat human beings as capital, based on an unclear or undefined ethical principle.

This study purports to estimate the human capital of the families using Wold's latent variables modeling with partial least squares and fitting Dagum model of income and wealth distribution to the family human capital estimates. Before this a brief analysis and assessment of the two traditional methods of estimating human capital, i.e. the retrospective and the prospective methods, is presented in Sections 2 and 3. Wold's latent variables modeling and method of estimation is discussed in Section 4. Section 5 presents the case of estimating the human capital as a single latent variable. Section 6 deals with the estimation and distribution of human capital for the U.S. in 1983 and 1986 using the Federal Reserve Board (FRB) sample surveys of wealth distribution. Section 7 presents the conclusions.

## 2. THE RETROSPECTIVE AND PROSPECTIVE METHODS

Two methods of estimation were advanced in the literature: (i) the retrospective, which deals with the cost of production, and (ii) the prospective, which deals with the capitalized earnings approach. The former estimates the cost of producing a human being which might be either net or gross of maintenance, whereas the latter estimates the present actuarial value of a human being's expected income, also net or gross of maintenance.

Ernst Engel (1883) is credited to be the first to apply the retrospective method. He considers three (lower, middle and upper) German social classes and applied a simple formula to estimate the cost  $c_i$  ( $i=1,2,3$ ) at birth of each class, assuming that the first year cost is  $c_i q_i$ , growing afterward at an arithmetic progression of ratio  $c_i q_i$ . Hence, at age  $x$ , the monetary value of a human being belonging to the  $i$ -th social class becomes:

$$(1) C_{ix} = c_i [ 1 + x + q_i x(x+1)/2 ], \quad i = 1,2,3; \quad x \leq 26.$$

Engel estimates  $c_i$  to be 100, 200, and 300 marks for the lower, middle, and upper German social classes, respectively; he makes  $q_i = q = 0.10$ , and assumes that at the age of 26 a human being is fully produced.

Regardless of the simplicity of Engel's assumptions, his approach should not be taken as an estimate of an individual human capital or the monetary value of a human being. It is only a historical cost estimate, that neglects to include interest, and is done within a strict marginalist approach because of the omission to impute social cost such as education, health service, sanitation, and the social cost of those that did not survive.

William Petty ([1690], 1899) is the most prominent founder of the Political Arithmetick school of economic thought and the forerunner of applied econometrics. Petty is credited to be the first to applied the prospective method to estimate the human capital of a nation.

Unlike Engel's approach that is microeconomic, since he estimates an individual human capital, Petty's approach is macroeconomic, because he purports to estimate a nation human capital without passing through the step of aggregation. However, as Engel, his assumption are extremely simple. Petty estimates England's national income and deduces from it the property income to get an estimate of the wage bill or earned income. He considers it a flow of annual income to perpetuity, hence his estimate of England human capital at a given year is its wage bill divided by the market rate of interest. Besides his interest in public finance, hence in taxation, Petty's interest in human capital was also motivated by his interest in asserting the economic power of England, the economic effects of migration and the cost of human life lost in war.

A rigorous scientific approach to estimate an individual human capital applying actuarial



mathematics is developed by Farr (1853). He estimates an individual human capital as the present actuarial (weighted by the survival probability) value of the expected annual earnings, net of maintenance cost (personal living expenses).

T. Wittstein (1867) combined both Farr's prospective and Engel's retrospective approaches to estimate a person human capital as a quantitative base to assess compensations for loss of life. Wittstein's approach is limited by the unacceptable assumption of equalizing lifetime earnings and lifetime maintenance.

Dublin and Lotka (1930) adopt Farr's approach and make further contributions to the cost and money value estimate of individuals. They estimate the human value at birth  $V_0$  as the actuarial value of a flow of net earnings  $y_x E_x - c_x$ , where  $x$  is the age of an individual,  $y_x$  is earned income from age  $x$  to  $x+1$ ,  $E_x$  is the probability of being employed at age  $x$ , i.e. the proportion of individuals employed from age  $x$  to  $x+1$ , and  $c_x$  is the cost of leaving from age  $x$  to  $x+1$ . Being  $i$  the discount rate,  $p(a, x)$  the probability of surviving at age  $x$  of a person having an age  $a < x$ , and  $\omega$  his maximum possible age, generally made equal to 100, Dublin and Lotka deduce the following net value of a human being at birth:

$$(2) \quad V_0 = \sum_{x=0}^{\omega} v^x p(0, x) (y_x E_x - c_x), \quad v = 1/(1+i).$$

Hence, the present net value at age  $a$  is,

$$(3) \quad V_a = \sum_{x=a}^{\omega} v^{x-a} p(a, x) (y_x E_x - c_x).$$

Since  $y_x E_x - c_x$  stands for the net earnings of a person from age  $x$  to  $x+1$ ,  $c_x - y_x E_x$  stands for the net costs, and

$$(4) \quad C_a = \sum_{x=0}^a (1+i)^{a-x} (c_x - y_x E_x) / p(x, a)$$

is the net cost at age  $a$  of rearing a person from birth to age  $a$ . The denominator in (4) implies that  $C_a$  includes the per-capita net cost for the surviving population at age  $a$  of those that died at age  $x < a$ .

It follows from (2)-(4) that

$$(5) \quad C_a = V_a - V_0(1+i)^a / p(0, a).$$

Farr's, Wittstein's and Dublin and Lotka's contributions stem from their professional interest on life insurance. On the other hand, very often, economists acknowledge that investment in human capital contributes to increase the productive capacity of the labor force, hence, to increase earnings capacity. However, with the main exceptions of Petty, Cantillon, von Thünen, Marshall, I. Fisher and J. M. Clark, they "neither attempted an evaluation of human capital nor employed the concept for any specific purpose", as Kiker (1971, p.57) asserts. Among them we should include A. Smith, Malthus, Say, S. Stuart Mill, List,

Bagehot, N. Senior and Walras. Most of them do not go much further than embracing and commenting A. Smith's thought in the *Wealth of Nations*. A. Smith (1776, B.I, Ch.X) advances five main circumstances which make up for differential pecuniary gain in employment. They are: (i) the agreeableness or disagreeableness of different employment; (ii) the different difficulty and expense of learning them; (iii) the different job security in them; (iv) the different amount of trustworthiness required in them; and (v) the different probability of success in them.

Commenting on the second circumstance, which directly concern the amount of human capital, A. Smith observes that: "A man educated at the expense of much labor and time to any of those employments which require extraordinary dexterity and skill, may be compared to one of those expensive machines. The work which he learns to perform, it must be expected, over and above the usual wages of common labor, will replace to him the whole expense of his education, with at least the ordinary profits of an equally valuable capital". Then he adds the following relevant observation related to the life expectancy at A. Smith's time: An educated man "must do this too in a reasonable time, regard being had to the very uncertain duration of human life, in the same manner as to the more certain duration of the machine".

In the second half of the twentieth century many researchers have estimated the earning function and the rates of return to years of schooling. Besides, three main research purporting to estimate the U.S. human capital were done by Kendrick (1976) and Eisner (1985), applying the retrospective (cost of production) approach, and by Jorgenson and Fraumeni (1988), applying the prospective approach.

### 3. SOME COMMENTS ON THE RETROSPECTIVE AND PROSPECTIVE METHODS

Section 2 presented the retrospective and prospective methods of estimating human capital. The retrospective or cost of production method is deficient mainly because of the following three reasons:

- (i) It fails to account for the social cost borne by a society in the estimate of human capital, such as public investment in education;
- (ii) In the cost estimation of human capital, it does not take into account variables such as home conditions (parent's occupation and education, availability of dictionary, encyclopedia, and library at home) and community environment;
- (iii) The cost of production estimates completely ignores the genetic contribution to the human capital estimation, including in it health condition.

Points (i) and (ii) come under the general heading of *nurture*, whereas point (iii) mainly belongs to *nature* and is independent of the human being's race, religion, gender, high, weight, etc.

On the other hand, although being scientifically rigorous and relevant, the prospective method requires information that, *ex ante*, are not available. Its estimates are as good as the data base used .