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Modern Human Capital Analysis: Estimation of US, Canada and Italy Earning Functions

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Analisi moderna del capitale umano: stima delle "earning functions" di US, Canada ed Italia.

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Abstract

The aim of this paper is not to supply a synthesis of the Chicago School human capital theory, but rather to define and analyze the earnings functions and their relations with the human capital concept. The earnings functions are an easy and flexible tool, for the analysis of the investments in education, that, in the formulation introduced in this paper, do not require hardly available data. But they don't seem to be a suitable model for the human capital analysis in its ample definition.

Using Italian, Canadian and US data provided by Luxembourg Income Study, some different formulations of the Mincer's earning function are estimated and compared, analyzing the effects of some socio-demographic variables on the rate of return of education. Results reflect the different labor market structure across the studied country.

1 Introduction.

The Department of Economic Affairs of the United Nations (1953) defined *investment in human capital* as investments made to increase the productivity of the labor factor.
A country's future production can be developed, not only by increasing the conventional capital stocks, but also through investments in education and on-the-job training, immigration, acquisition of knowledge, and improvement of health and life standards of the workers as well as many other intangible factors that affect the productivity of labor.
Since both conventional capital and human capital involve costs and promises of future earnings, it is possible to recognize a symmetry between the two concepts. *Human capital is a estimation of the ability of a person to produce labor income.*
Therefore, human capital support policies should include: 1) promotion of educational projects and scholarships, 2) development of research, 3) improvement of social and family life standards, and 4) development of political tools to control immigration.
Human Capital estimates (individual or aggregate) have been applied in economics for the determination of the dynamics of the employment earnings market (earning functions)[1], for the analysis of the income distribution, for the investigation of the economic growth and for the measure of the social costs of emigration. But, despite the wide definition given, in most empirical studies human capital is estimated solely by the education level of the subject. The reliance on education level is due, in part, to the difficulties of measuring to components of human capital.

Since the dawns of the economic theory authors have theorized that the human qualities should be handled within the structure of the capital. In the XVIII century the Fisiocratis considered unproductive the mental efforts of lawyers, educators and men of science nonetheless Adam Smith, in 1776, affirmed that "the salaries vary with the cost to learn the job"[2].
One detailed review of the human capital classical theory is given by Kiker's works[3].

Since the fifties, the modern theory of the human capital was largely, but not exclusively, produced and developed by the Chicago School, under the intellectual inspiration of Theodore W. Shultz.
The modern human capital research, since its origin, was focused on two complementary aspects: Shultz, Denison and Griliches had used the theory of the human capital to analyze the productivity and the economic growth, on the other front, Jacob Mincer, Gary S. Becker and their " followers " had set the general theory and they had focused the attention on the study of the relations between human capital and labor income.
Mincer and Becker, during the following twenty years, evidenced the remarkable costs of the investment on the individual (included the time costs); analyzed the scholastic and post-scholastic investments; formalized the optimization rules of the choice of such investment and estimated the relations between the salaries and the different categories of age, occupation and education.
In the seventies, the increasing attention among the researchers to the analysis of the relationships between distribution of the income and human capital theory produced the valuable works of Griliches and Mason (1972), Welch (1975), Blaug (1976) and Rosen (1977).

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[1] Mincer (1970), Di Bartolo(1999a).

[2] Sahota (1978) p.11

[3] Kiker (1968,a) e (1968,b)

The theory developed by the Chicago School is rather different from the classical theories, it is in fact the postulation of individuals' rational behavior. The investments on the individual are, in fact, according to such hypothesis, the fruit of a rational choice (made by the individual or his/her family) finalized to optimize the future earnings. The choice is taken on the base of the probable actual values of alternatives life cycle earnings, discounted with an opportune rate.
Rosen (1977, p.4) affirms that the modern human capital theory moves the attention from the salaries, to the cycle of working life earnings. The theory of the human capital is, in fact, the heart of the permanent earnings theory.
The research in the past forty years has been focused on each expenditures that can influence the future productive ability of the individual and the accordingly ability to produce income: migration, health, school and formation, search of employment, information's evaluation, preschool investment in children, family and population. [4].
The published papers emphasize that the education is a main key to interpret the other forms of investment effects.
Bluag (1976) affirms that the "hard core" of the theory of the human capital is the education, despite the other mentioned components, its relevance is undeniable. The schooling and the formation are moreover easily controlled political tools, and for this reason desirable.
For these reasons very often, and improperly, the theory of the human capital has been used as synonym of investment in education.
The aim of this paper is not to supply a synthesis of the works of Becker and Mincer and of the other exponents of the in Chicago School, on the contrary, it is to define and analyze the earnings functions and their relations with the human capital concept. Using Italian, Canadian and US data provided by Luxembourg Income Study, some different formulations of the Mincer's earning function are also estimated and compared.

2 Earning functions and rate of return of education

In the 1960 T.W Schultz wrote[5]: “I propose to treat education as an investment in man. Since education becomes a part of person receiving it, I shall refer to it as *human capital* . Since it becomes an integral part of a person, it cannot be bought or sold or tread as property under our institution. Nevertheless, it is a form of capital if it renders a service of value.”
An ample part of the human capital literature, in which the pioneering works of Becker (1964) and Mincer (1958) analyze the earnings functions for the study of the effects of investments in schooling and on-the-job-training, on the level and interpersonal distribution of the life cycle earnings. Willis (1986) to such a purpose defined earnings function: “any regression of individual wage rates or earnings on a vector of personal, market and environmental variables thought to influence the wage”

[4] For a review see Sahota(1978) p.12 and Mastrodonato (1991) pp.135-142.

[5] Schultz(1993), p.115

Much of recent applied work has been focused on estimating a version of the following earnings (or income) function:

[1] $$y_i = f(s_i, A_i, \mathbf{z}_i) + u_i$$

where *y* can be a measure of wage rates, earnings or income, *s* is a measure of schooling, usually in units of years or grades completed, ***z*** is a set of other variables assumed to affect earnings and to be different for each individual[6], *A* is an unobservable variable referring the individual's ability, *u* is a disturbance, representing the other not explicitly measured forces affecting earnings, assumed to be distributed independently of the **z**'s and possibly of *s*, and *i* is an index identifying a particular individual in the sample.

The traditional pre-1960 view among economists was that the demand for post-compulsory education was a demand for a consumption good, and for this very reason depended on given "tastes", on family incomes and on the price of schooling in the form of tuition costs[7]. Beginning with the studies by Becker (1962), Hanoch (1967), Hansen (1963), they started to analyze schooling choices like investment choices. Statistical earnings functions have been used to estimate the rate of return of education, whose definition, given by Rosen (1977), could be the following:

Consider an individual who can pursue two courses of action, yielding two alternative earnings streams $\{g_t\}$ and $\{y_t\}$,where $t = t, t+1, \ldots N$; N is the age of retirement from the labor market, and t the starting point of the two courses (both g_t and y_t can be negative if the choice leads to some periods of expenses without income). For example, if a decision are being incurred upon high school education, $\{g_t\}$ might represent the decision to enter the labor market and $\{y_t\}$ the decision to go to college. Let $h_t = y_t - g_t$ and suppose $h_t < 0$ for some values of *t* so that the decision problem is not trivial.

Define net present value of the choice (V_t) as

[2] $$V_t = \sum_t h_t / (1+r)^t$$

where *r* is a rate of interest, that, with a simplification, is supposed to be constant in all the period of investment. An action is chosen to maximize the present value: if $V_\tau > 0$ then $\{y_t\}$ is a better option. The *internal rate of return* (r) of a choice is defined by setting the sum in [2] equal to zero ($V_\tau = 0$), after replacing *r* by r.

There are a lot of practical problems and simplifications hidden in the given definition: principally either $\{g_t\}$ or $\{y_t\}$ can be observed for a particular person, not both. Most data provides limited panel information consequently it is difficult extrapolate lifecycle earnings developments. Moreover it is necessary to create appropriate comparison groups for individuals.

If schooling is assumed to be a full-time activity with students supplying no labor in the market and it is supposed that the only cost of schooling are forgone earnings, then age-

[6] They could be years of experience, post school investments, characteristics of the family of origin.

[7] There was the complication that demand in education also involved an "ability" to consume the good itself, but most economist left this issue to sociologist and social psychologist. See Blaug, (1976)

earnings profile would be a step function with an initial phase, during the pre-school and school years when *y=0*. Assume that the individuals enter the labor force immediately after the completion of schooling and that the age of retirement from the labor market (*N*) is independent from the choice of education, the height of the step at the point of entry into the labor market is determined by length of schooling, "ability" and other variables like family characteristics, school prestige, place of living etc.
Instead of [2], always considering the [1], the following expression can be used to determine the internal rate of return of education:

$$[3] \qquad V(s) = \int_0^N f(s, A, \mathbf{z}) e^{-rt}\, dt$$

where V(s) is the discounted value of future earnings (at "birth"[8]) for the given schooling choice s, y= $f(s, A, \mathbf{z})$ is the anticipated earnings function and *r* is the (constant) interest rate by which the individual discounts the future. In the [3] post-schooling investments are not considered. The variables *A, r* and **z** are taken as exogenous, thus, in this simple model, the only decision variable affecting human capital value is *s*.
The optimal schooling choice is the value of *s*, *s** that maximize the [2.3]
Rosen (1977) define the marginal internal rate of return of schooling as that rate of discount, $r(s_1, s_2)$ such that the present value of the earnings streams, net of the direct costs of education which are associated two different schooling levels[9], s_1 and s_2, are equated.
If $s_2 = s_1 + d$, where d>0, considering [3], *r* is the discounted rate (*r*) that solves the following expression:

$$[4] \qquad V(s) = V(s + d)$$

In general such rate must be calculated using numerical methods.

The estimation of statistical earnings function and internal rate of return ideally needs complete longitudinal data of earnings of individuals, associated with information about costs supported for education (schooling, post schooling), family background and personal characteristics, ability, etc. Unfortunately such ideal data are seldom available.
Empirical studies estimated different forms of the [1], the choice was been often forced by the lack of information.
An excellent and complete review, that underlines the evolution of the thematic, can be found in the followings three works: Rosen (1977), Willis (1986) and Card (1995).

3 Mincer's Earning Function

In a hypothetical economy made up of workers that differ only for years of schooling (*s*), age (*t*) and, consequently, length of labor experience (defining $x = t - s - b$, where *b* is age at the beginning of school) but are otherwise observationally identical, the earnings function [1] can be rewritten in the following form:

[8] Or before deciding on schooling

[9] In the considerate case only foregone earnings.

[5] $y = j\,(s, x) + u$

where u is a residual with zero mean and $j\,(s, x)$ is the functional form, that best fit the data and usually assumed to be positive monotonic in s. Rosen (1977) affirmed that the function $j\,(s, x)$ in [5] may be interpreted as a hedonic price function which reflects the equilibrium of the supply and demand for workers at each level of schooling and experience.
Willis (1986, p.532) reports that if the rate of growth of y at any given level of s is independent of the experience level then the function [1] can be written in the following weakly separable form:

[6] $y = f(s)g(x) + u$

and, accordingly, the present value of lifetimes earnings [3] assumes the following form:

[7] $V(s) = f(s)e^{-rs}\int_0^N g(x)e^{-rt}dt$

The estimated marginal rate of return of education *(r(s))* is given by the following expression[10]:

[8] $\hat{r}(s) = \dfrac{j'_s(s,x)}{j\,(s,x)} = \dfrac{f'(s)}{f(s)}$

Mincer (1974), using as a starting point the schooling model

[9] $\ln y_x = b_0 + b_1 s + u$

and introducing the post-school investments[11], developed and estimated this specific functional form for the [5], that, for the influence of Mincer's works, is often referred to as "the" human capital earnings function:

[10] $\begin{aligned}\ln y_x &= \ln(f(s)) + \ln(g(x)) \\ &= b_0 + b_1 s + b_2 x + b_3 x^2 + u\end{aligned}$

where y_x is the "net earning" after x years of experience (y_x="gross" earnings minus the resources that the worker devotes in furthering his job skills and acquiring job-related information).

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[10] Considering the [4] and letting d→0.

[11] Mincer, J (1974),, pp.9-11 and cap. 5.

In model [10] the schooling coefficient (b_1) provides an estimate of the rate of return of education, which is supposed to be constant. The age profiles of earnings are observed to be concave, that concavity is captured in the [10] by the quadratic experience term (x^2), whose coefficient (b_3) is supposed to be negative while b_2 is positive.

From the theoretical point of view Mincer, through the [10], assumes that abilities (skills), that the worker acquires through education and on the job formation, can be considered as a homogeneous stock of human capital, which influence his productivity. In this specification the influence is independent from the kind of job and from the employer. The author assumes besides that every worker possesses the same internal rate of return of education and that everyone invests the same fraction of their capability to earn in formation.

Willis (1985, pp.542-543) defines the assumptions that Mincer provides for the specification of the earning function [10] "a combination of theory and pragmatism", but he recognizes that such functional form represents an approximation of the unknown human capital function. The human capital models underline a lot of non observable variables, including the human capital itself. For this reasons the [10] "represents a pragmatic method of incorporating some of the major implications of the optimal human capital models into a simple econometric framework, which can be applied to the limited information available in Census-type data."

An alternative to the [10] is represented by the following function

$$[11] \qquad \ln y_x = b_0 + b_1 s + b_2 s^2 + b_3 x + b_4 x^2 + b_5 xs + u$$

If β_5=0 then the [11] has the form described by the [6] and accordingly, thanks to the [8], $r(s) = b_1 + 2b_2 s$.

4 Some criticisms to the earning function approach

Any earning function formulation is based on the key assumption that it carefully represents the whole opportunities of an individual. One criticism moved to the investments in human capital theory consists in denying the ability of any known earnings function to suitably measure those opportunities. Such problem has been reported in literature as " self selection ". It is in part due to insufficient available information.

Various authors acknowledge, in fact, the presence of not observed and, in some cases, unobservable variables, that influence the profile of the labor incomes and the rate of return of education. To such a purpose the ability variable, that interacts with the level of schooling, is often included in the model..

Griliches, Chamberlain, Willis and Card, among the others, consider, under different hypothesis and with different methods, the ability component. What seems to emerge from the comparison of methodologies and results is that the proxy variables used to explain the latent components, are often disputable. Moreover the use of ordinary least squares estimation method, in presence of errors of measure and latent variables, leads to an underestimate of the rate of return of education. Therefore it is preferable to use methodologies that 1) keep track of the latent nature of such variables, as in Griliches (1977) and Griliches and Chamberlain (1977) where analysis are done through simplified structural models, or 2) apply instrumental variable estimation method to increase the information of the observed level of education.

Even though different authors recognized the presence of a latent component in the nature of human capital (generally identified it with ability), it is necessary to underline that, before Dagum (1994) and Dagum and Vittadini (1996), the human capital has never been defined a latent variable and estimated with latent variables techniques[12].

A further criticism to the earning function theory, introduced by Mincer as a human capital analysis tool, is moved by the followers of the "screening theory", which is based on the followings two assumptions:

1) a fast completion of the studies is indicative of great ability, and consequently it shows a great productivity and capability to earn;

2) the years spent at school, without being concluded with a degree, don't increase the earnings and the repeated years represent a negative signal for the employer.

Both, the human capital and the screening theory postulate that the years of school increase the salaries; in the capital human theory that happens because every year of additional school increases the stock of human capital, in the screening theory the years of education are a signal of great ability, but the time spent without the attainment of a degree have not effect or could have a negative influence.

Groot and Oosterbeek (1994, p.321) attempt to verify the validity of one theory respect the other, they decomposed the observed years of schooling in real, repeated, jumped and inefficient years getting results that seem to confirm the human capital theory.

5 Earning function estimation results

The third paragraph presents the definitions of earning function and of rate of return of investments in education. The Mincer's formulation is here rewritten:

$$[12] \qquad \ln y = b_0 + b_1 s + b_2 x + b_3 x^2 + u$$

where

ln y = logarithm of labor income[13],

s = years of schooling,

x = years of experience calculated as x = t-s-6 (where t is the age).

In the [12], the rate of return of education r is supposed to be constant for every level of schooling and experience and it is given by the coefficient of *s*, (b_1).

This work estimates the [12] using individual data integrated with family information from Canada, US (1994) and Italy (1995), kindly provided by the Luxembourg Income Study (LIS)[14] and acquired from national official survey sources[15].

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[12] Di Bartolo (1999) cap.5

[13] In Mincer's formulation the income should be considered after education and training expenses, in the practice such information are not available.

[14] The LIS project, founded in 1983, has four main goals: i) to create a database containing social and economic data collected in household surveys from different countries; ii) to provide a method allowing researchers to use the data under restrictions required by the countries providing the data; iii) to create a system to allow remote access and to elaborate data using computer networking and iv) to promote comparative studies on income aggregates.

[15] Italia '95= Indagine Campionaria sui Bilanci delle Famiglie, Banca Italia, US '94=March Current Population Survey, FBS; Canada '94=Survey of Consumer Finances

At this stage the LIS database includes about 70 datasets for 25 countries, covering the period from 1967 to 1995. Most datasets include three different files, the first with data at the household level (allowing sometimes also a disaggregation among multifamily households), the second at the individual level and the third at the child level. One of the main issues in setting up such a database is to elaborate data from single national household budget surveys transforming variables and re-weighting single cases in order to allow a satisfactory international comparison. Of course, perfect comparability will never be reached but the LIS database allows a good degree of comparability between several countries.
Starting from the hypothesis, confirmed by numerous past studies, that the rate of return differs according to the sex, I divided the available data on individuals in two groups and I estimated the earning function [12] for male and female both separately and jointly.
In a third step I added at the analysis some demographic variables, as, for example, the living place, and the type of employee, to extrapolate possible effects on the rate of return of education and on the salaries.
All the analysis was made with the SAS procedure REG. It is necessary underline that only full time workers with earnings greater than zero have been considered.
Tab.5.1 describe the utilized variables.

Tab 1 Description of the variables.

Variables names	*description*
ln y	Logarithm of the labor income (Canada and US: gross income, Italy net income)
s	Years of schooling (generally from 0 to 21)
x	Years of experience ($x=t-s-6$)
ds	Sex (*ds*=1 male, *ds*=0 female)
dw	Kind of occupation (dw=1 professionals and managers, dw=0 other occupation)
dl	Living place (*dl*=1 big urban center, *dl*=0 small center or rural zone)
dng	Employment sector (*dng*=1 private sector employee, *dng* = public sector employee)
z1	$=s \cdot dw$ (effect combined of schooling and occupational prestige)
z2	$=s \cdot dl$ (combined effect of schooling and living place)
z3	$=s \cdot dng$ (combined effect of schooling and employment sector)

Tab. 2 displays the estimation results for Canada, Italy, and US jointly for female and males. Tab. 3 presents the results obtained analyzing separately the two groups.
To verify the hypothesis that other variables could influence the intercept and the effect of the years of schooling variable on the logarithm of the income, I added to the function [12] three dummy variables (living place, type of occupation and employment sector),

described in Tab. 1, and the three combined effects of such dummies with the *s* variable (z_1, z_2 and z_3). The adjusted function is given by the following expression

[13] $$\ln y = b_0 + b_1 s + b_2 x + b_3 x^2 + b_4 dl + b_5 dng + b_6 dw + a_1 z1 + a_2 z2 + a_3 z3 + e$$

The best[16] results for the three countries (US, Canada and Italy) and both sexes, obtained with the stepwise model selection method[17], are reported in Tab. 4.
The [13] could be rewritten to simplify the understanding and the comparison of the results described in Tab. 4 and to put in evidence the z_i (i=1,.. 3) effects:

[14] $$\ln y = (b_0 + b_4 dl + b_5 dng + b_6 dw) + (b_1 + a_1 dw + a_2 dl + a_3 dng) s + b_2 x + b_3 x^2 + e$$

For example, considering the managers and professionals, living in a big urban center and working for a (private sector) firm (*dw*=1, *dl*=1 and *dng*=1) the intercept and the years of schooling's coefficient are given respectively by the following two expressions

[15] $$intercept = b_0 + b_4 + b_5 + b_6$$

[16] $$s\ variable's\ coefficient = b_1 + a_1 + a_2 + a_3$$

The tables from Tab. 5 to Tab.12 show the data introduced in Tab. 4, combined, using the [14] for eight groups obtained with the combinations of the dummies. By hypothesis the *x* and x^2 variables' coefficients do not change between the groups.

Tab 2 Mincer's earning function estimation results: male and female groups jointly analyzed.(standard errors in brackets)

	US '94		**Canada ' 94**		**Italy ' 95**	
N	40205		25127		5600	
F-stat	4034.5		1382.7		443.2	
R^2	0.231		0.142		0.192	
const.	8.72332	(0.01426)	9.32681	(0.01610)	9.019	(0.0361)
s	0.07455	(0.00074)	0.04276	(0.00082)	0.042	(0.0015)
x	0.04261	(0.00113)	0.03883	(0.00125)	0.043	(0.0037)
x^2	-0.00080	(0.00003)	-0.00074	(0.00004)	-0.001	(0.0001)

[16] All the estimated parameter are significative.

[17] In all the cases the model selected by the STEPWISE procedure coincide with the model selected by the BACKWARD procedure see SAS Institute Inc. (1990) Vol.2, p.1400 for a description of the selection methods.

Tab 3 Mincer's earning function estimation results: male and female groups analyzed separately

	US 94				Canada 94				Italy 95			
	Male		Female		Male		Female		Male		Female	
N	23536		16669		14665		10462		3392		2208	
F-stat	3048.9		1734.0		1052.6		601.5		380.5		171.4	
R^2	0.280		0.238		0.177		0.147		0.251		0.189	
const.	8.766	(0.018)	8.607	(0.021)	9.464	(0.019)	9.128	(0.025)	9.019	(0.036)	8.800	(0.048)
s	0.074	(0.001)	0.079	(0.001)	0.039	(0.001)	0.051	(0.001)	0.042	(0.002)	0.048	(0.002)
x	0.048	(0.001)	0.033	(0.002)	0.042	(0.002)	0.028	(0.002)	0.043	(0.004)	0.031	(0.005)
x^2	-0.001	(0.0001)	-0.001	(0.0001)	-0.001	(0.0001)	-0.001	(0.0001)	-0.001	(0.0001)	-0.001	(0.0001)

Tab 4 Mincer's earning function with dummies estimation results: male and female groups analyzed separately.

	US 94				Canada 94				Italy 95			
	Male		Female		Male		Female		Male		Female	
N	23536		16669		14665		10462		3392		2208	
F-stat	1309.3		765.2		541.1		438.5		155.9		92.3	
R^2	0.308		0.293		0.205		0.227		0.269		0.227	
const.	9.000	(0.037)	8.913	(0.053)	9.631	(0.021)	9.578	(0.029)	9.189	(0.049)	9.288	(0.068)
s	0.047	(0.002)	0.047	(0.004)	0.030	(0.001)	0.018	(0.002)	0.026	(0.003)	0.020	(0.004)
x	0.048	(0.001)	0.032	(0.001)	0.041	(0.002)	0.026	(0.002)	0.045	(0.004)	0.027	(0.005)
x^2	-0.001	(0.0001)	-0.001	(0.0001)	-0.001	(0.0001)	-0.001	(0.0001)	-0.001	(0.0001)	-0.001	(0.0001)
dw	0.314	(0.033)	0.307	(0.037)	-0.125	(0.035)	-0.097	(0.042)	0.238	(0.076)	0.040	(0.026)
dl			0.078	(0.040)					0.021	(0.011)	-0.044	(0.017)
dng	-0.150	(0.034)	-0.256	(0.038)			-0.169	(0.009)	-0.260	(0.038)	-0.503	(0.060)
z1	-0.010	(0.002)	-0.007	(0.003)	0.014	(0.002)	0.018	(0.003(	-0.013	(0.005)		
z2	0.008	(0.001)	0.005	(0.003)	0.003	(0.001)	0.008	(0.001)				
z3	0.012	(0.002)	0.015	(0.003)	-0.007	(0.001)			0.022	(0.003)	0.032	(0.005)

Tab 5 *Private sector (dng=1), managers and professionals (dw=1), the resident in big centers (dl=1)*

	US 94		Canada 94		Italy 95	
	Male	**Female**	**Male**	**Female**	**Male**	**Female**
const	9.164	9.042	9.506	9.312	9.189	8.781
s	0.057	0.060	0.040	0.045	0.035	0.052
x	0.048	0.032	0.041	0.026	0.010	-0.005
x^2	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001

Tab 6 *Private sector (dng=1), managers and professionals (dw=1), resident in small centers (dl=0)*

	US 94		Canada 94		Italy 95	
	Male	**Female**	**Male**	**Female**	**Male**	**Female**
const	9.164	8.964	9.506	9.312	9.168	8.825
s	0.049	0.055	0.036	0.036	0.035	0.052

Tab 7 *Public sector (dng=0), managers and professionals (dw=1), resident in big centers (dl=1)*

	US 94		Canada 94		Italy 95	
	Male	**Female**	**Male**	**Female**	**Male**	**Female**
const	9.314	9.298	9.506	9.481	9.449	9.284
s	0.045	0.045	0.047	0.045	0.012	0.020

Tab 8 *Public sector (dng=0), managers and professionals(dw=1), resident in small centers (dl=0)*

	US 94		Canada 94		Italy 95	
	Male	**Female**	**Male**	**Female**	**Male**	**Female**
const	9.314	9.220	9.506	9.481	9.428	9.328
s	0.037	0.040	0.044	0.036	0.012	0.020

Tab 9 *Private sector (dng=1), other occupations (dw=0), resident in big centers (dl=1)*

	US 94		Canada 94		Italy 95	
	Male	**Female**	**Male**	**Female**	**Male**	**Female**
const	8.850	8.735	9.631	9.409	8.950	8.741
s	0.067	0.067	0.026	0.027	0.048	0.052

Tab 10 Private sector (dng=1), other occupations (dw=0), resident in small centers (dl=0)

	US 94		Canada 94		Italy 95	
	Male	**Female**	**Male**	**Female**	**Male**	**Female**
const	8.850	8.658	9.631	9.409	8.929	8.785
s	0.059	0.062	0.022	0.018	0.048	0.052

Tab 11 Public sector (dng=0), other occupations (dw=0) resident in big centers (dl=1)

	US 94		Canada 94		Italy 95	
	Male	**Female**	**Male**	**Female**	**Male**	**Female**
const	9.000	8.991	9.631	9.578	9.210	9.244
s	0.055	0.052	0.033	0.027	0.026	0.020

Tab 12 Public sector (dng=0), other occupations (dw=0), resident in small centers (dl=0)

	US 94		Canada 94		Italy 95	
	Male	**Female**	**Male**	**Female**	**Male**	**Female**
const	9.000	8.913	9.631	9.578	9.189	9.288
s	0.047	0.047	0.030	0.018	0.026	0.020

All the findings can be considered coherent with the results presented by analogous studies and with how postulated by the economic theory. As anticipated, the coefficient of x^2, for all the considered functions, is negative (even if just slightly) showing the concavity of the age-earnings profile.

Tab. 3 shows as in every considered country, even if the constant (b_0) is superior for the men's group, the rate of return of the investment in schooling (b_1) is bigger for the women. With the exception of Italy, the following tables generally confirm such findings.

A more elevated women's rate of return of education is not necessarily a signal of grater receptiveness to education, but could be explained by the economic structure of the three considered countries. As underlined by the presented tables, at parity of education women generally earn less than men, therefore education, could be for them, more than for the individuals of masculine sex, a discriminating factor that allows to reach more elevated incomes. Such results are less evident for the United States, with respect to Canada and Italy.

The tables from 5 to 12 emphasize ulterior interesting findings.

Canada, Italy and US evidence quite similar results, even if in some cases the relations between income and education are slightly different for Italy. This can be partly due to the dissimilar nature of the data, but also to some difference of the job market structure.

Analyzing the tables from 5 to 12, It is possible to observe as, for every combination and every country, the male group constant is grater than the female group one; such discrepancy amplifies when we consider the private sector (*dng*=1).

Comparing the tables related to "managers and professionals" (*dw*=1) with the respective tables related to the "other occupations" (*dw*=0), it is immediate to observe that, when *dw*=1, the constant is higher, but *r* is generally lower.

The rates of return of education for Canada and US do not appear very different in the male and female groups but they change a lot across the other characteristics analyzed. A bigger discrepancy can be observed for Italian managers and professionals of the private sector (*dw*=1 and

dng=1). This discordance could be explained considering that in Italy women's presence among managers and professionals is usually high profile but not as diffuse as in North America. Italian and US results show that *s* variable's coefficient for the female group is generally higher than the male one, an inverse relationship is observed just for *dw*=0 and *dng*=0. The analysis of the Canadian data, contrasting with the results in tab 3, establishes that *r* for male group is greater or at least equal to the female one accept for private sector employee living in big cities (*dng*=1 and *dl*=1).

Concluding it is necessary to stress that for the three considered countries the rate of return of the investment in education results generally, to be inferior in the public sector respect to the private one. It could prove that public sector wages and salaries are less flexible in comparison to the private labor market dynamics.

6 Conclusions

The theory of the human capital produced by the Chicago School and developed in the last forty years, although based on an ample definition, fixes as central point of the analysis the scholastic and post-scholastic education. It assumes in fact that the "traditional" education, providing knowledge, professional skills and capacity of problem analysis, allows increasing of worker's income and productivity.

Sahota (1978, p.14), in a survey on the personal income distribution theories, affirms: "…no income distribution theory can claim to be complete without taking the dynamic nature of human capital into full account. While there is little doubt that the human capital theory of income inequalities will go down in economic history as a turning point in general economic theory, its critics point out several shortcoming in it."

One of the criticisms moved by Sahota is on the assumption of individuals rational behavior, which should maximize the expected value of the future earnings stream.

He, in fact, affirms that, even if it is realistic to suppose that individuals perform a long run economic strategy, it is not acceptable that the rate of return, in such evaluations, is considered constant.

A second criticism, moved also by Griliches (1977), is based on the observation that, despite numerous studies analyze the human capital as cause of the personal earnings, the motivations, that lead the families and the individuals to invest in education (and therefore in human capital), are rarely analyzed.

Non institutional forms of education (es. education in family, trips etc.) are not considered too.

In the last edition of his famous book “Human Capital”, Becker stresses the importance of the family role in the education, in the knowledge and in the skills of progenies.

The families take decisions concerning the number of children based on their own income. The expenses that they sustain influence the investment in human capital: it exists, in fact, a negative relationship between such type of investment and the growth of the population.

Besides Mincer, in his studies, emphasizes how the institutional education explains no more than seven percent of the differences in earnings.

In conclusion earnings functions are an easy and flexible analysis tool of the investments in education, that, in the introduced formulation, do not require hardly available data. However considering the given definition, in author's opinion, they are not a suitable model for human capital analysis. First because earning functions don't consider adequately the unobservable component of human capital, secondary because they don't allow to estimate the latent variable human capital and to find its distribution among individuals.

7 References

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