Iranian Economic Review, Vol.10, No.14, Fall 2005

Estimation of the Level and Distribution of Households' Human Capital the Case of Tehran[1]

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Abstract

The main goal of this paper is to estimate the level and distribution of human capital (HC) in Tehran province, Iran. In doing this we have first reviewed theoretical and empirical literature of human capital. And then we used Dogum Method for estimation of level and distribution of households' human capital in Tehran. The Dogum Method is based on three old methods of estimation. We used latent variable, because human capital is a qualitative variable. The results show that there is a positive relation between variables which are related to human capital and formation of human capital in Tehran province. Also, the results indicate that household income and human development are respectively the most and the least effective on households' human capital in Tehran.

Keyword: Human Capital, Latent Variable, Discount Rate, Dogum Method.

1- Introduction

Nowadays, economists pay attention to new capital in Economics. Human Capital (HC) and Social Capital (SC) are new capital. Some economists believe that these two kinds of capital are very important for economic growth. The concept of human capital was first introduced and estimated by Petty (1690). Cantillon (1755) discussed the concept of HC and estimated the cost of rearing a child until working age. The concept of functional income distribution was introduced by Ricardo (1817). The first research on the personal (size)

1- I wish to thank everybody who help us in doing this research, especially, Rahman Saadat and Mina Mehrnosh, We thank Ali Hematjou for his helpful suggestions and the discussion on the Econometrics results and robustness.

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distribution of income was done by Pareto (1895, 1896, 1897). He was the first to specify, estimate and analyze a model of income distribution. Both the functional and personal income distributions are assumed to be generated by two variable factors, human capital (that generates earned income); and capital (that generates other incomes). The theoretical production function that underlies both of these concepts of distribution includes labor as an argument. Unfortunately, labor is generally measured in these production functions as man-hours worked or as persons employed full-time per year. While it is useful to partition the labor force (into full-time, part-time and unemployed workers) for labor market studies, it can be misleading to do so when analyzing economic processes involving production, growth, distribution and social welfare. The usual specification of the production function is, In virtually all micro and macro applications of the production function, what is really of interest is of course, employed human capital (H) and capital (K), not just a generic labor stock L. Output is produced, income is earned and input prices are set based on the quality of the experience, training and schooling embodied in labor (its skill set), not just based on the magnitude of the labor stock L. Denison (1967, 1974) was among the first to make this adjustment in empirical specifications of the production function and Dogum (1978) was among the first to note this in work on the functional income distribution.

There is a few research in this subject in this Iran. One of them is Hematjoo and Yavari (2001) research. They estimated accumulation of human capital in East Azarbaijan province's Householders. In another research, Saadat and Yavari (2000) surveyed the relationship between human capital and economic growth in Iran. They explained position of stock of human capital in Iranian Economy. They also investigated causality relation between Human Capital and Economic Growth in Iran economy. To do this, they used Hisao method. The result show that there is one-way relation between human capital and oil revenue from oil revenue to human capital and there are two-way relation between non oil revenue and stock of human capital in Iran.

In this paper we study the relationship between the human capital and other variables which affect on accumulation of human capital in Tehran province's Householders. The main aim of this paper is estimating level and distribution of human capital (HC) in Tehran province, Iran. For doing this, first we have reviewed theoretical and empirical literature of human capital, and then we used

Dogum Method for estimation level and distribution of human capital in Tehran province's household in Iran. The Dogum Method has been formed three old method of estimation of human capital. We used latent variable, because human capital is a qualify variable.

The rest of this paper is organized as follows: we review the methods of estimation Human Capital in Section 2. Section 3 we used Dogum Method for estimation level and distribution of human capital in Tehran province's household in Iran and this section also presents and discusses the empirical findings. Conclusion is in section 4.

2- Human capital: methods of estimation

Traditionally, two methods of HC estimation were advanced, (i) the prospective, and (ii) the retrospective. In the 1980s, a third method was proposed as a proxy or an indicator of the stock of HC, i.e. (iii) a measure of the average education stock, enrolment data, or years of schooling of the working age population. In next Section, we will present a new method (Dogum Method) of estimation of the personal HC as a latent variable combined with the prospective method of estimation.

2-1 The prospective approach

This was the first method used to estimate personal and national HC. Petty (1690) was the most prominent founder of the Political Arithmetic school of economics and a precursor to modern applied econometrics. He was the first author to apply the prospective method to estimate the HC of a nation with the purpose of assessing the loss sustained by a plague, by the slaughter of men in war, and by migration. His method purported to offer also a sound base for taxation and to evaluate the power of a nation.

Petty estimated the HC of England as the difference between his estimation of national income (£42 million) and property income (rent of land 8 millions and profit 8 millions) capitalized in perpetuity at a 5% interest rate, arriving at a total HC estimation of £520 million; or a per capita estimation of £80. Although Petty's approach was a very crude one, it had the merit of raising the issue, giving an answer, and making an economic and social interpretation of the result obtained.

Let V(X) be the net value of a person of age x ; $V^X = (1+i)^{-X}$ the present value of a unit of money due *x* years later, where *i* is the discount rate $P(a,X) = \frac{L(a+X)}{L(X)}$ the probability at age a of living to age a+x; l(x) the population of age x; y(x) the annual earnings of a person of age x; E(x) the annual rate of employment at age x, hence , U(x)=1- E(x) is the annual rate of unemployment at age x; and c(x) is the annual cost of living of a person at age x. For the sake of notational simplification, we work with age x, instead of x+1/2 as the representative age in a calendar year.

The net value of a human being (net HC) at age a is the present actuarial value of a flow of net annual expected earnings, i.e.

$$V(a) = \sum_{x=a}^{\infty} v^{x-a}[Y(x)E(x) - C(x)]P(a,x) \qquad (1)$$

Hence, at birth,

$$V(0) = \sum_{X=0}^{\infty} V^X[Y(X)E(X) - C(X)]P(0,X) \qquad (2)$$

i.e. Barriol's social value of an individual.

It follows from Eq. (1) that the net cost at age *a* of rearing a person from birth to age *a* is,

$$C(a) = \sum_{x=0}^{a-1} \frac{(1+a)^{a-X}[C(X) - Y(X)E(X)]}{P(X,a)} \qquad (3)$$

The denominator in Eq. (3) means that C(a) includes the per capita net cost for the surviving population at age a of those that died at age $X \prec a$.

It follows from Eqs. (1)–(3) that,

$$V(a) = \frac{(1+a)^a}{P(0,a)}\left\{\sum_{X=a}^{\infty} V^X[Y(X)E(X) - C(X)]P(0,X)\right\} = V(0)\frac{(1+i)^a}{P(0,a)} + C(a)$$

Hence,

$$C(a) = V(a) - V(0)\frac{(1+i)^a}{P(0,a)} \qquad (4)$$

The gross HC at age a is obtained from Eq. (1) after making $C(X) = 0$ for all x, i.e.

$$\text{Gross} \quad HC(a) = \sum_{X=a}^{\infty} V^{X-a} Y(X)E(X)P(a,X) \qquad (5)$$

In the second half of the 20th century, little research was done using the prospective method.

2-2 The retrospective approach

Although A. Smith implicitly proposed the cost of production (''a man educated at the expense of much labour and time'') as a main determinant of differential wages, Engel (1883) was the first to advance and apply the retrospective method of HC estimation. He was not attracted to the prospective method because of the weight he gave to outstanding outliers such as Goethe, Newton, and Benjamin Franklin. He argued that the HC of these extreme cases could not be estimated for lack of knowledge about their future earnings; instead, he said it was possible to estimate their rearing costs to their parents.

Studying the budget of Prussian working families, Engel adopted very crude assumptions to arrive at the estimation of the cost of production. He considered three (lower, middle, and upper) classes, assumed a cost $C_i (i = 1,2,3)$ at birth of the ith class, increasing it annually in an arithmetic progression until the age of 25. At 26, he considered that a human being was fully produced. For each year of age, Engel increased the cost c_i at birth by the constant amount $c_i q_i$, hence, the annual cost of rearing a person of age x<26, belonging to the ith class, becomes $c_i + xc_i q_i$ Adding the historical cost from birth up to the age x<26, he obtained

$$C_i(X) = C_i[1 + X + \frac{q_i X(X+1)}{2}] \qquad (6)$$

as the cost of production of a human being up to the age x<26.

3- The educational stock approach

Unlike the prospective and the retrospective methods that deal with HC estimation, this approach considers the educational attainment or school enrolment by countries or regions as proxies for HC. Hence, it circumvents the estimation of HC. Barro (1991), Mankiw et al. (1992) used measures of school enrolments; Romer (1989), Azariadis and Drazen (1990) used adult literacy rates.

4- Dogum Method

The new approach presented in this paper to estimate HC further develops the method introduced by Dogum (1994), Dogum and Vittadini (1996). It estimates personal (such as households, families, member of the labour force, and working age population) HC, its size distribution, the average level of HC by age, and the average level of HC of the population. From this approach, we arrive at a specific monetary value of HC and not just at a proxy index number for HC. The estimation of personal HC, its distribution, the average HC by age, and the average HC level of the population (of economic units) are obtained from sample surveys of income and wealth data as explained below in points 1-6.

1. From the information available in a sample survey, we choose what we retain as the most relevant indicators that determine the HC of each economic unit. Unfortunately, the available sample surveys do not provide socioeconomic information of the parents of the household head and spouse, nor measure of intelligence, ability and other indicators of genetic endowment of the household head and spouse. From a selection of p indicators, we specify the following HC linear equation,

$$Z = L(X_1, X_2, ..., X_p) \qquad (7)$$

where *z* stands for the standardized (zero mean and unit variance) HC latent variable, and $X_1, X_2, ..., X_p$ are p standardized indicators.

2. Once Eq. (7) is estimated, to pass from z(i) in Eq. (7) to h(i) in an accounting monetary value, where i stands for the i^{th} economic unit, we apply the following transformation:

$$h(i) = \exp(z(i)) \tag{8}$$

The average value of h(i) is

$$AV(h) = \frac{\sum_{i=1}^{n} h(i)f(i)}{\sum_{i=1}^{n} f(i)} \tag{9}$$

where n is the sample size and f(i) is the weight attached to the i^{th} sample observation, because these observations are not purely random.

3. To estimate average personal HC, we proceed as follows,

3.1. We order the sample observations by age of the economic units (age of the head when the economic units are households or families).

3.2. For each age x we obtain the total earnings and the size of the population they represent.

3.3. The total earnings by age is equal to the sum of the products of the earnings of each economic unit of age x times the number of economic units it represents in the population, i.e. its weight. Dividing this total amount by the total weight by age, we obtain the average earnings by age.

3.4. To eliminate large random fluctuations, we smooth the average earnings and the total weights by age, applying a seven-term weighted moving average (3-5 MA). Hence, our smoothed average earning y(x) and its corresponding weight f(x) are our representative cross-section data for the estimation of HC. The levels of y(x) reveal mainly the ability, drive, determination, dynamism, choice (investment in education, on the job training, post school investment, health, etc.), home, and social environment of the average economic units of age x.

3.5. In the absence of temporal technological changes and without increases in HC productivity, the representative average earnings of the economic units of age x, t years later, is given by the average earnings y(x-t) of the economic units of age x-t. Hence, under these simplified assumptions, the cross-section and life-cycle average earnings are equal. Thus, given a discount rate i and the mortality table of a population, the HC of the average economic unit of age x is,

$$h(X) = \sum_{t=0}^{90-X} Y(X+t)P(X,X+t)(1+i)^{-t} \qquad (10)$$

for x=20, 21, …, 70, i.e. for a working population age 20–70.

It follows from Eq. (10) that the weighted average of the population HC is,

$$AVHC(h) = \frac{\sum_{x=20}^{90} h(x)f(x)}{\sum_{x=20}^{90} f(x)} \qquad (11)$$

3.6. In real life, economic processes incorporate technological changes, higher educational levels, hence, the productivity of HC increases through time yielding a process of economic growth. For these reasons, the cross-section average HC $h(x)$ will not be equal to the life cycle (time series realization) of average HC at age x. assuming a HC productivity increase at the annual rate r, it follows from this assumption and Eqs. (10) and (11), that average HC at age x is:

$$h(x) = \sum_{t=0}^{90-X} y(x+t)P(x,x+t)(1+i)^{-t} \qquad (12)$$

and the corresponding average HC of the population is

$$AVHC(h) = \frac{\sum_{X=20}^{90} h(X).f(X)}{\sum_{X=20}^{90} f(X)} \qquad (13)$$

4. To arrive at the current monetary value of the HC estimation of the n sample observations we obtain the ratio between the average HC given by Eq. (11) and the average of the transformation (Eq. (8)) given by Eq. (9), and multiply it by h(i) as given by Eq. (8). Hence, the HC of the i th sample observation is,

$$HC(h) = \frac{AVHC(h)}{AV(h)}, \qquad i=1, 2,\ldots, n. \tag{14}$$

Which the vector of human capital in the corresponding national monetary equals one. It represents the empirical HC corresponding to the sample survey object of research.

6. Table 1 presents an illustration of the proposed new method of HC estimation.

Table 1: Illustration of a new proposed approach to estimate the level and the distribution of human capital of the members of a sample survey

Step A

LATENT VARLABLE APPROACH

Estimation of Latent Variable $Z(i)=L(x_{1i}, x_{2i},\ldots, x_{ni})$ representing the i-th economic unit in a sample survey where z(i) is the HC estimation with zero mean and unit variance.

$h(i)=\exp(Z(i))$

Transformation h(i)=exp(z(i)) of the estimated latent variable into an accounting monetary value and estimation of its mean value AV(h). i.e.

$$AV(h)=\sum_{t=o}^{\infty} h(i)\,f(i)) / \sum_{t=0}^{\infty} f(i)$$

Step B

ACTURALAL MATHEMATICAL APPROACH

Actuarial estimation, in monetary values, of the average human capital h(x) by age of the economic units, i.e.

$$h(x)=\sum_{t=0}^{90-x} y(x+t)\,p(x,x+t))(1+i)^{-t}$$

Estimation of the average human capital of the population in monetary unites. i.e.,

$$AV(HC(h))=\sum_{x=20}^{70} h(x)\,f(x)) / \sum_{x=20}^{70} f(x)$$

SYNTESIS

HUMAN CAPITAL ESTIMATION AND DISTRIBUTION

Estimation of the HC(i) of the i-th economic unit in a sample survey and its size distribution, i.e.

$$C(i)=h(i)\,Av(HC(h))/AV(h)\ ,\ i=1,2,\ldots,n$$

3- A case study: the 2000 Iran's human capital

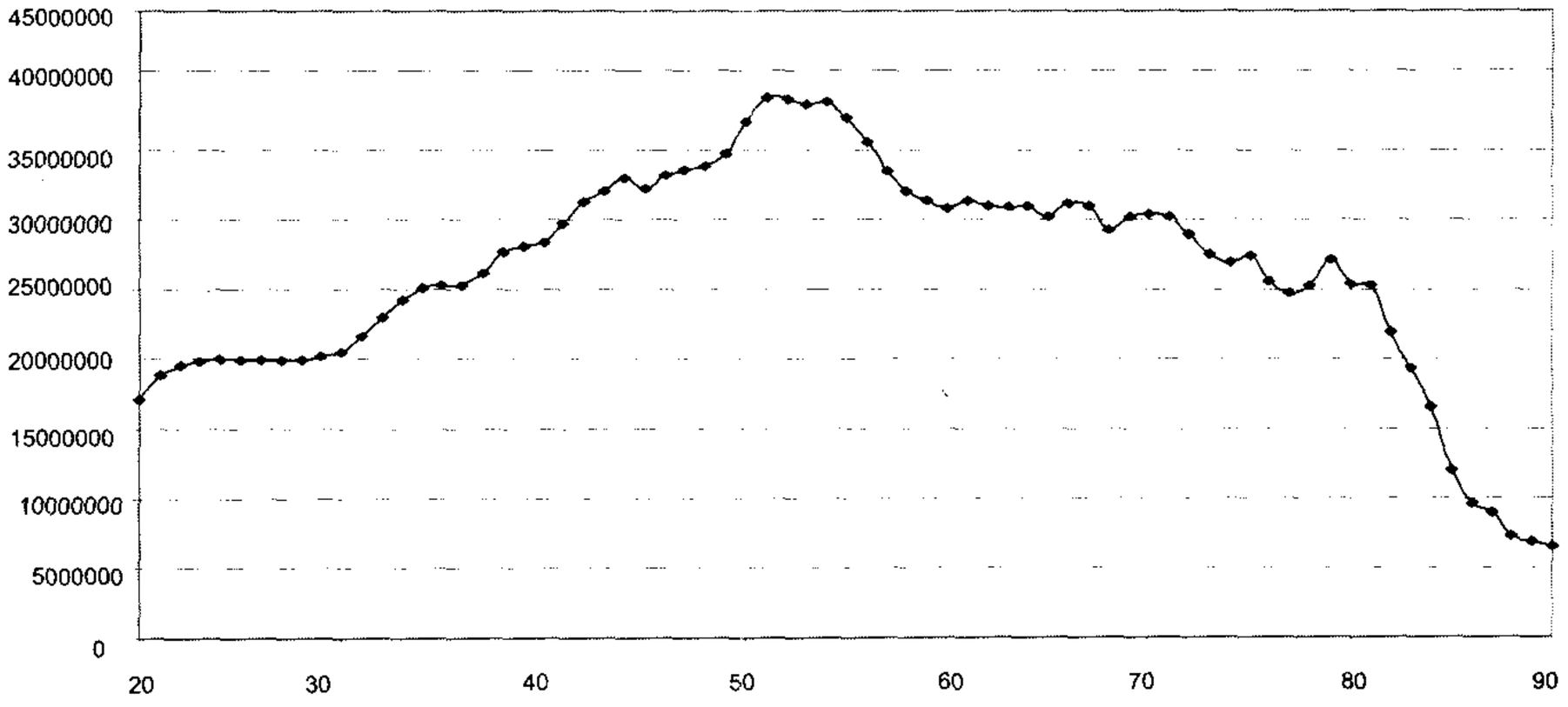
The proposed new method of HC estimation presented in last Section allows, (i) the HC estimation of each economic unit as a latent variable; (ii) the average HC by age; (iii) the average HC of the population of economic units; and (iv) using the estimations obtained in (i)–(iii), to pass from the HC estimation as a latent variable with zero mean and unit variance to the HC estimation in monetary values; and (v) to obtain from (iv) the size distribution of HC with mean given by (iii). With the scope of testing the power and the validity of this approach, the method presented in last Section, as outlined in Table 1 and in (i)–(v) above, is applied to estimate the HC of the 2687 household observations of Tehran province in the 2000 Iran sample survey of consumer finances. Hence, the choice of indicators from this sample survey allows the specification of a multivariate equation to estimate the household HC as a latent variable.

Estimation of the 1983 Iran average household HC

Using the magnetic tape of the 2000 Iran sample survey and, we obtain, by age of the household head, (i) the households earned income; (ii) the weight each household represents in the Iran population; and (iii) the average household earnings.

We use the 2000 Iran sample and we got values of the weights and of the average earnings by age of the household head. Fig. 1 presents the observed and the smoothed average household earnings by age x.

Fig 1: Tehran observed household earned income by age of the head



Estimation of HC of each sample observation and its size distribution

From the Tehran province in 2000 Iran sample survey, we select the following indicators to estimate the latent HC variable by household: x_1, region of residence; x_2, sex of the household head; x_3, age of the household head; x_4, Literacy status; x_5, years of schooling of the household head; x_6, degree of the household head; x_7, marital status; x_8, age of the spouse years of full-time work of the household head; x_9, years of schooling of the spouse years of full-time work of the spouse; x_{10}, degree of the spouse; x_{11}, sex of the spouse; x_{12}, total wealth; and x_{13}, number of children. Hence, the latent variable z in Eq. (7) is specified as a linear function of qualitative and quantitative variables. we obtain the following estimation of z_i, i=1, 2, …, 2687, where the numbers in parentheses are the Student-t:

$$\begin{aligned} Z_i = & \underset{(4.92)}{0.063X_{1i}} + \underset{(3.07)}{0.035X_{2i}} + \underset{(2.74)}{0.041X_{3i}} + \underset{(6.27)}{0.071X_{4i}} + \underset{(3.48)}{0.052X_{5i}} + \underset{(7.51)}{0.10X_{6i}} + \underset{(7.18)}{0.146X_{8i}} \\ & + \underset{(8.05)}{0.145X_{9i}} + \underset{(11.80)}{0.145X_{11i}} + \underset{(53.78)}{0.671X_{12i}} \qquad (15) \\ & R^2 = 67\% \qquad F = 613.27 \end{aligned}$$

Where z_i and x_{ij}, j=1, 2,…, 13, are standardized variables. The corresponding R^2 and F values are, R^2=0.67 and F(11, 2687)=613.27.

Given that we are working with a cross-section sample of 2687 observations, the coefficient of determination R2 and the F value are exceptionally high, hence, clearly accepting the goodness of fit of Eq. (15) even at the 1% level of significance.

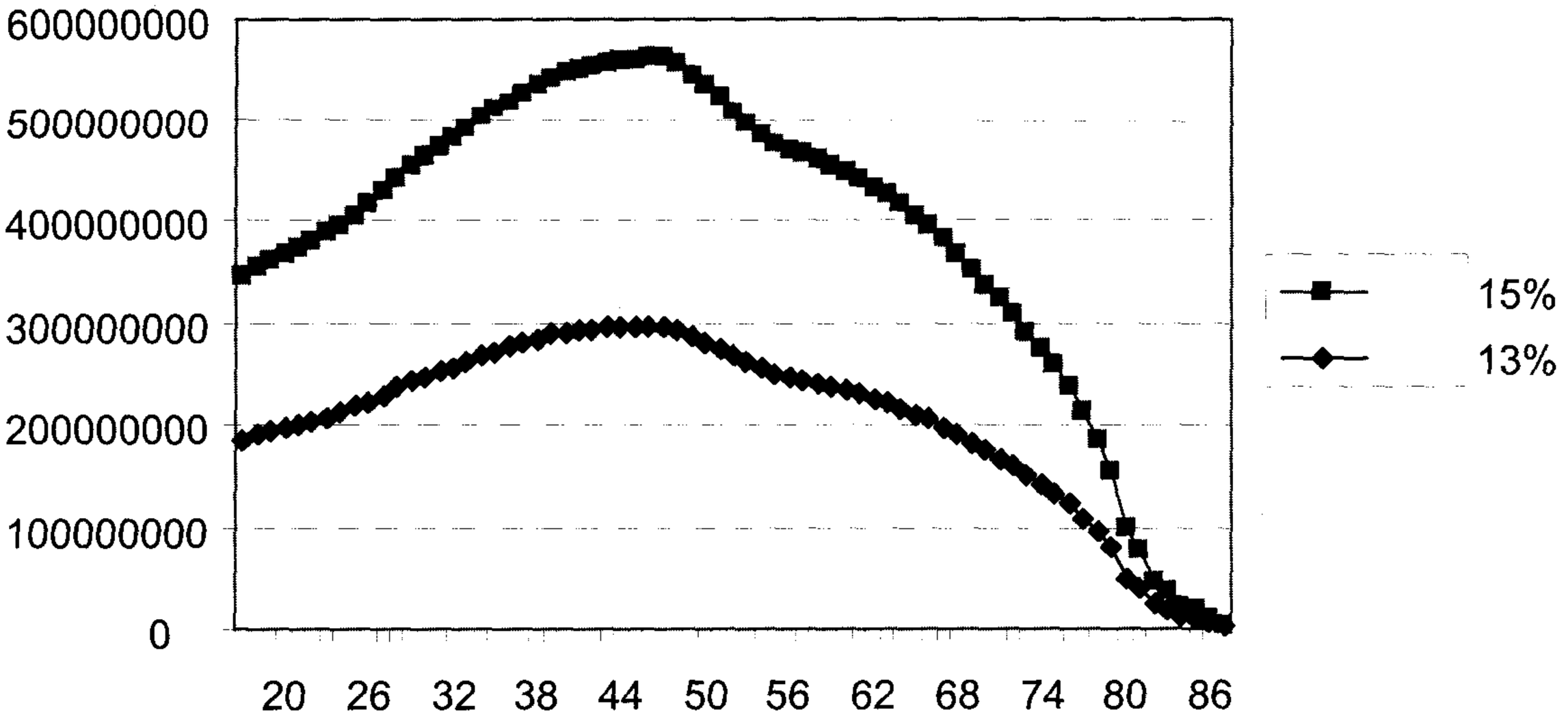
The results also show that there are positive relation between all of variable which related to human capital and formulation of human capital in Tehran province. Also, the results indicated that household income and human development have the most and the least effective on human capital formation in level of Tehran province's householders.

Estimation of the 1983 IRAN average household HC

To obtain the life cycle HC estimation of the representative household by age of the head, we apply Eq. (15), where r stands for the annual rate of

productivity growth. The gross values of the average life cycle HC by age of the household head, for i=0.13 and 0.15, are presented in Fig. 2 and Table 2 and Table 3 , columns 2 and 4.

Fig 2: 2000 Tehran province household human capital by age of the head (cross-section) (at 13 and 15% discount rates).



We obtain the 2000 Iran average household HC, i.e. the cross-section averages,

$$AVHC(h) = 250296802 \quad \text{for} \quad i = 13\% \qquad (16a)$$
$$AVHC(h) = 224170789 \quad \text{for} \quad i = 15\% \qquad (16b)$$

Applying the transformation (Eq. (8)) to the estimations of *zi* in (Eq. (15)), we obtain the accounting monetary estimations of hi, i=1, 2, …, 2687, each one having a weight that corresponds to the number of households each sample observation represents in the 2000 Iran population. Dividing each hi by its mean obtained from Eq. (9) and multiplying by the average household HC given by Eq. (16a) or Eq. (16b), we obtain the household HC distribution in Iran Rials with mean equal to $250296802, if the flow of average earnings is actualized at 13%, or with mean equal to $224170790, if it is actualized at 15% discount rate.

Table 2 - Tehran province in household human capital by age of the head (present values at 13% discount rates)

Age	Average of Human Capital	Age	Average of Human Capital
20	185597039	56	260356660
21	190352863	57	254328559
22	193776580	58	249942768
23	196892244	59	246695082
24	200074068	60	243797652
25	203504640	61	241203060
26	207435156	62	237680880
27	211892701	63	234144123
28	216938961	64	230296454
29	222623483	65	225835450
30	228783587	66	221727811
31	235434702	67	216030303
32	241638207	68	209816674
33	247094569	69	204886252
34	251826752	70	198267121
35	256281657	71	190564543
36	261106963	72	182095478
37	266527733	73	173990466
38	271704851	74	166438309
39	275766291	75	158679714
40	279997902	76	149366757
41	284458408	77	140858426
42	287923544	78	132308954
43	290142621	79	121890126
44	291773192	80	108084137
45	292547304	81	94160245
46	294296104	82	78504606
47	295243085	83	50481998
48	295879856	84	40268728
49	296313714	85	24394502
50	295870641	86	19410365
51	292737275	87	12058431
52	287276673	88	9139044
53	281235338	89	4911240
54	274825086	90	2453108
55	267395201		

Table 3: Tehran province in household human capital by age of the head (present values at 15% discount rates)

Age	Average of Human Capital	Age	Average of Human Capital
20	160021056	56	234391007
21	164306312	57	228928282
22	167250616	58	225111934
23	169870365	59	222458686
24	172539105	60	220190568
25	175440967	61	218270455
26	178833350	62	215458347
27	182750937	63	212672164
28	187265560	64	209616581
29	192438968	65	205984269
30	198119614	66	202753737
31	204337052	67	197961308
32	210150529	68	192675785
33	215254173	69	188723181
34	219664081	70	183109462
35	223825688	71	176425220
36	228398304	72	168976570
37	233623616	73	161901102
38	238666010	74	155399716
39	242643595	75	148713187
40	246852480	76	140470404
41	251364238	77	133045252
42	254948492	78	125594364
43	257342708	79	116260873
44	259201691	80	103463827
45	260251128	81	90473550
46	262345355	82	75619862
47	263705021	83	47075210
48	264826034	84	37636800
49	265822563	85	22053754
50	266016604	86	17618176
51	263558848	87	10627854
52	258776715	88	8097985
53	253406289	89	4233410
54	247652181	90	2131874
55	240842866		

4- Conclusion

The main aim goal of this paper is estimating level and distribution of human capital (HC) in Tehran province, Iran. For this main, first we have reviewed theoretical and empirical literature of human capital, and then we used Dugom Method for estimation level and distribution of human capital in Tehran province's household in Iran. The Dogum Method has been formed three old method of estimation of human capital. We used latent variable, because human capital is a qualify variable. We obtain the household HC distribution in Iran Rials with mean equal to $250296802, if the flow of average earnings is actualized at 13%, or with mean equal to $224170790, if it is actualized at 15% discount rate. The results also show that there are positive relation between all of variable which related to human capital and formulation of human capital in Tehran province. Also, the results indicated that household income and human development have the most and the least effective on human capital formation in level of Tehran province' householders.

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