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The Impact of Human Capital (Health and Education) on Labor Productivity; a Composite Model Approach- a Case Study of Iran

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Abstract

Productivity promotion has received a key attention in contemporary macroeconomic analysis. Productivity of labor driven, in particular, by human capital (i.e. health and education), is seen vitally more important. Labor qualities in terms of health and education (treated as flow and stock variables), have a bearing on labor productivity. The main objective of this paper is to identify the influence on productivity of health and education and delineate their relative impact, using a composite approach to human capital. Towards this end, an Autoregressive-Distributed Lag (ARDL) technique was applied to measure labor productivity over the period 1974-2014. Based on the result of model findings, attempt was made to evaluate their short and long term effects. The model applied in this paper has examined the impact of two key variables i.e. per capita capital and capacity index, in addition to human capital index (health and education) influencing collectively on labor productivity. The results indicate that all variables (Excluding the index of composite Human Capital, flow) are bearing a positive and significant impact on labor productivity in the long run. The coefficient of composite human capital index (health and education, flow variables) was greater than that of composite human capital (health and education, stock variables).

Keywords: Labor Productivity, Health, Education, Composite of Human Capital Index.
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1. Introduction

The role of human capital, emphasized by endogenous growth theory in the 90´s, is now universally accepted as being indispensable for

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economic growth. Low levels of human capital represent a barrier to development and impede improvements in productivity and competitiveness. But human capital performance mainly has been linked to levels of education and some other factors such as innovation, technical progress and research and development. In the other words, most studies on education considers it as a measure of human capital, but pay less attention on health- based human capital .though Improvement in quality of labor is considerable, but improving health of the labor is additionally more important since it is being considered as determining factor in the human capital stock. Naturally, improving public health as human capital can increase the efficiency and effectiveness as equal as labor productivity, therefore, investment in this area will have a strong bearing on economic efficiency.

Sustained output growth and labor productivity improvement depends on the levels of human capital whose stock increases as a result of better education, better health, and new learning and training activities. A labor force without a minimal level of education and health is incapable of maintaining a state of continuous growth. Human capital is the input associated with the human body and brain: good health, strength, brainpower, native ability, are elements that suggest a direct link between the human body and productivity. Recognizing the importance of health, models of economic growth have been extended to include this factor as a human capital input.

Investment in human capital means to investment in areas such as experience, health, education which altogether leads to enhanced labor productivity. Evidence has shown that human training and investment in education is not only reduce the mortality rate and malnutrition, but will also lead to increase in life expectancy.

Therefore, countries that are seeking to increase competitiveness and productivity invest more in abilities, skills and capabilities of labor. Moreover, investing in human capital is not limited only on investment in education, but also investment in human health. And even over the last two decades, there has been more attention to this aspect in empirical literature at global level.

According to Asian Productivity Organization (APO) Productivity Database 2014, output per person employed in Iran was 17.3 dollars per hour (at constant basic prices, using 2011 PPP) in 1980 that annual growth around 1.5% increased to 28.3 dollars per hour in 2012. Therefore, increase in quality of human resources to improve labor productivity is vitally urgent, especially improvement in main human resources factors such as health, and education. To achieve this target in Iran at higher level requires fundamental economic, social and institutional changes to be introduced in the in Iran.

In the future, it is possible to improve it at the national level through institutional reform in the education sector (formal and informal), but there are various reasons for health sector to face with threats which tend to deteriorate gradually physical, mental and social status of human resource in long run.

This research aims to study the impact of human capital (health and education) on labor productivity in the economy of Iran. This article applies the composite approach and relies on the Principal Components Method (PCM) and on human capital index both in stock and flow nature[1].

Accordingly, this paper is organized in four sections. The first part will examine literature and empirical studies. The second part deals with the methodology and introduces variables and statistical data and human capital index. In the end the paper analyzes the results and draws conclusion.

2. The Literature

2.1 A Conceptual Framework

A key property of the neo-classical growth model is that an economy that starts out further below its own steady-state position tends to grow proportionately faster. The key word, however, is "own", for empirical studies showed that this so-called absolute catch up proposition clearly failed in terms of the cross-country data. Many studies -for instance Barro (1991), Barro and Sala-i-Martin (1992) and Mankiw, Romer, & Weil (1992) - have shown that so-called conditional convergence is empirically more successful. In these studies country-specific characteristics are taken into account to control for differences in steady states.

1. The concept of a "stock" variable can be defined at a given moment, and this variable is a record of the past and cannot be changed in a moment at a time, but concept of "flow" is always defined in a time frame and can be changed abruptly. Therefore, flow variables are instantaneous and policy-driven, but the accumulation variable (stock) needs time to change.

Schultz (1961) and Mushkin (1962) have shown long time ago that human capital can also be accumulated through improvements in health.[1] The recent macroeconomic studies that have focused on growth, per capita income and productivity growth, put emphasis on physical capital and human capital including education and health as durable and sustainable capital (Locus1988, Romer1986). Inclusion of human capital into macro-modeling for productivity was first developed by Solow (1956) in order to incorporate neo-classical growth accounting equation. In Solow's approach, measurement of productivity growth is based on multi-factor productivity, and Solow residual indicate such a growth in productivity. There are some assumptions in this approach; first, technological progress is an exogenous variable. This model employs standard neo-classical production function with decreasing returns to scale. Second, in Solow's term, population growth and the saving rate are also exogenous. Thus, these two variables are determining factor in per capita income.

In this model, two inputs variables, namely labor and capital, take the same value for their marginal product. The production is described by a Cobb–Douglas production function. Production at *t* point of time is:

$$Y_t = K_t^{\alpha}(A_t L_t)^{1-\alpha} \quad 0 \langle \alpha \langle 1 \qquad (1)$$

In which, y = production, K= capital, L =labor and A= technological progress. It takes the growth of A and L as n and g respectively:

$$L_t = L_0 e^{nt}$$
$$A_t = A_0 e^{gt} \qquad (2)$$

Therefore, the growth rate of effective labor (AL) will be equal to n + g. It is assumed that a constant share of the product is saved (s).

If k is defined as capital per unit of effective labor (k =K/AL) and y is defined as the level of output per unit of effective labor (y =Y/AL). Then:

$$\hat{k} = sy_t - (n + g + \delta)k_t$$
$$= sk_t^{\alpha} - (n + g + \delta)k_t \qquad (3)$$

In this equation, δ shows the rate of depreciation. Equation (3) implies that k will finally tend to steady state as defined by sk*= (n+g+&) k* or:

$$\overset{*}{k} = [s/(n + g + \delta)]^{(1-\alpha)} \qquad (4)$$

It is observed that the ratio of constant capital to labor is related directly to saving rate and is inversely related to population growth rate. By putting equation (4) in production function (1) and have it in the natural logarithm form, we will have the following equation:

$$\ln[\frac{Y_t}{L_t}] = \ln A_0 + gt + \frac{\alpha}{1-\alpha}\ln(s) - \frac{\alpha}{1-\alpha}\ln(n + g + \delta) \qquad (5)$$

The model assumes, payments to factors of production is equal to their marginal product. Coefficients of saving and population growth with assumption δ and g to be the same. Moreover,

$lnA_0=a+\varepsilon$

$$\ln[\frac{Y_t}{L_t}] = a + \frac{\alpha}{1-\alpha}\ln(s) - \frac{\alpha}{1-\alpha}\ln(n + g + \delta) + \varepsilon \qquad (6)$$

Assuming the independence of savings rate and population growth from country specific factors, this model can be estimated by OLS.

As such, equation (6) can be estimated by imposing restrictions and without restrictions on absolute values and different coefficient sign $\ln(n + g + \delta), \ln(s)$.

Mankiw, Romer and Weil (1992), by adding human capital, could change potentially structure of model. For example, Lucas assumes when capital human is constant, physical capital efficiency declines and human capital efficiency (physical + human) remains constant. It presumes production function as below is:

$$Y_t = K_t^{\alpha} H_t^{\beta} (A_t L_t)^{1-\alpha-\beta} \tag{7}$$

In which, H = human capital stock. s_k and s_h stand for share of capital and human capital in income. Then we will have:

$$\hat{k} = s_k y_t - (n + g + \delta) k_t \tag{8}$$

$$\hat{h} = s_h y_t - (n + g + \delta) h_t \tag{9}$$

It is further assumed that one isoproduciton function applies to physical capital, human capital and consumption, besides, as it is assumed both human and physical capital depreciate at the same rate. In addition, α+β<1 indicate the law of decreasing return to scale with respect to both human and physical capitals as mentioned above. If α+β=1 indicate the law of constant returns to scale with respect to production which fall in the realm of endogenous growth models. Equations (8) and (9) maintains steady state in the economy. The sustainability of growth is shown by following equations:

$$\overset{*}{k} = \left(\frac{s_k^{1-\beta} s_h^{\beta}}{n + g + \delta} \right)^{\frac{1}{1-\alpha-\beta}} \tag{10}$$

$$\overset{*}{h} = \left(\frac{s_k^{\alpha} s_h^{1-\alpha}}{n + g + \delta} \right)^{\frac{1}{1-\alpha-\beta}} \tag{11}$$

By replacing above equations in the production function and transforming into the natural logarithm, per capita income is derived as below:

$$\ln\left[\frac{Y_t}{L_t}\right] = \ln A_0 + gt - \frac{\alpha+\beta}{1-\alpha-\beta}\ln(n+g+\delta) + \frac{\alpha}{1-\alpha-\beta}\ln(s_k) + \frac{\beta}{1-\alpha-\beta}\ln(s_h) \tag{12}$$

Alike the model introduced model by Solow, in the enhanced model, the coefficients are treated as a function income share of factors. It is quite simply to be compared the predication of coefficient equations (6) and (12). Finding indicated that coefficient ln (S_k) is greater in new equation. Since savings leads to more revenue, its percentage of income would spend on human capital, is constant, increase human capital yet again at steady state. Thus, human capital will boost accumulation effect of income on physical capital. Another point in new model is that the absolute value of coefficient (ln n + g +&) is greater than the absolute value of coefficient ln (S_k). In other word means that according to the model population growth rate reduces more per capita income, because physical and human capital should be distributed among more addition population.

Relating life expectancy, health and education refer to traditional human capital theory this initial study began by Schultz (1961), Gray Becker (1964), Ben –Porras (1967) and Mincer (1974). This term is unclear to show multi human dimensional human capital. Health and education are the e main components of human capital. While investing on share of each of them as features of human capital increases efficient for individuals is important, there are several differences aspects between them. In human health theory is assumed that a nation who save knowledge and human health, indeed it increases productivity in market and non-market activities.

According to Grossman (1972), state of health of a person is stock, therefore, health is a capital commodity to bring healthy life for a person. In fact, health capital determines how long each person has at its disposal to earn money. This subject can be used to explain the concept of human capital and entered as symbolism of health in terms of growth models. Improve health makes not only promote economic growth, but also reduce loss of production due to absence from work of labors in order to be physical and mental illness. In addition, the improvement of health is released the resources that the absence of enough health causes to spend money for disease treatments instead of spending in some other efficient activities. Furthermore, theoretical health is identified simultaneously tracks which health of a person can affect productivity. It is possible for a healthy labor to have more physical and mental energy and less absence from work consequently more productivity. A person with higher life expectancy invest possibly more money in education and receive definitely more and also he motivates to save for retirement duration. This behavior leads to become more physical capital stock.

Indeed, Identification other factors of the relationship between health and other components of human capital by Meshkin (1967) has led to its expansion into health capital model by Grossman (1972). This model is more effective in health economy and education improves productivity in investment. Both education and longevity are considered as exogenous variables and are optimized high probability separately in health part. As a result, both human and health capital theory express unclear and incomprehensive mutual relationship between education, health and longevity. Accordingly, Galama and Van theory added some endogenous variables of composition of capital including skill, health and longevity in model for three periods of life education, work, and retirement. Crystal clear investing in the health capital covers health care and medical condition, while investing in skills includes the cost of education, training and vocational training. Retirement is part of life that people are allocated their time for leisure and investment in health.

Three features of human capital in this theory should be considered that, firstly, skill capital is determined wage rates, whilst health capital is determined how long a person has ability to work and both of them can reduce duration of illness at the same time, consequently impact on retirement and life expectancy at life cycle. Secondly, a person begins normally his life healthy and at the end of his life reaches to around zero level of health due to disability and natural death. In contrast, a person begins his life with limited skills and gradually improves them, then at the end of his life is accompanied by different mental health. This means that a person has a good chance to increase mental health until death by improving skills, while his health level reduces. Thirdly, life skills are mainly valuable immediate while health is valuable mainly delayed. Therefore, investment in skills of youth is very high, whilst investment in health aging is high.

2.2 Previous Studies

Numerous studies have examined the association between schooling or learning (including formal learning and non-certified learning) and productivity. On balance, the literature tends to find that learning has a significant and positive effect on productivity both at the micro (individual or firm) and macro (economy) level. Migration, the capacity to avoid unwanted fertility, and health outcomes are also forms of reproducible human capital. The framework set up by Mincer (1974) is enriched to allow for additional forms of human capital besides schooling.

Arshad and Malik (2015) showed that the quality of human capital (higher level of education and better health status) affected positively and significantly on the level of labor productivity in Malaysia. Health impact on productivity is more than that of education. One percent Increase in life expectancy leads to 14.0 percent increase in labor productivity. Shahraki and Ghaderi (2015) showed that the coefficient of education and health infrastructure on Gross domestic production (GDP) was positive and significant and one percent increase in infrastructure pertaining to health and education increases GDP by 0.06 percent. Ganyaupfu (2014) indicated that health and education affected positively and significantly on economic development in African countries, especially health had a significant effect on the development of this region. Studies of Umoru and Yaqub in Nigeria reveal that investment in health capital had a significant determining effect on labor productivity and labor skills. Therefore, health capital has obviously an interaction effect on labor productivity.

Saha (2013) showed one-way relationship between life expectancy and total factors productivity growth (TFP) and life expectancy appeared to have positive and significant effect on TFP. Furthermore, Hansen (2013) presented that life expectancy influenced positively and significantly on human capital of a labor. An increase of one percent in life expectancy raised human capital by 0.45 percent. Raiespour and Pajooyan (2013) applied a regional approach (28 provinces of Iran) to indicate that the government expenditure (current) in health sector had positive and stable effect on productivity of total factor production and government investments in health infrastructure had no effect on factors productivity.

Tang and Lai (2011) emphasized that the majority of macroeconomic policies focused on achieving higher growth in order to encourage investment in human capital such as health and education. Because both of them had uniquely positive and significant effect on production level and productivity. Ahmadi, Naji and Jandaghi (2010) demonstrated that the average years of labor education and ratio of health expenditure to GDP had positive and significant effect on total productivity. The causality test also showed a one-way causal effect running from human capital to TFP. Indeed, Temple (1999), in a survey of evidence on the “new growth” theory, could not cite any work that incorporates either the stock of, or investment in health human capital in explaining cross-country variation in growth of per capita income.

Chakroun (2009) demonstrated that there was a nonlinear relationship between national income and health expenditures across selected countries in OECD, and unlike the results of many studies, the average income elasticity was less than one (as a necessary commodity). Hanushek and Dongwook (1995) and Schultz (1999) suggest that health improves an individual’s mental and intellectual capabilities, leading to better educational outcomes.

Agenor (2008) examined labor productivity in context indigenous growth model. In this attempt, he once treated health as flow variable in another instance as stock variable in production and utility functions. The results indicated that there was a trade-off between increasing public expenditure and infrastructure. Therefore, the provision of infrastructure services leads to increase in the production of goods and health services and consequently to increase in productivity and output growth.

Soukiazis and Crav (2007) studied the impact of health and human capital on economic growth in some countries (low and high income countries). They applied various indices and estimating Panel data and GMM models to investigate these impacts. The finding indicated that health and human capital are important determinant on income for three main income groups. Health had greater effect on income differences between low and medium income countries, other human capital indices do not explain much on the differences in economic performance. Amini and Hejazi-Azad (2007) has shown in their studies that the labor productivity have increased by an annual average 1.8% over the past two decades of which 38.2 % is attributed to health promotion and health care.

Cole and Neumayer (2006) addressed the impact of malnutrition, malaria and waterborne diseases on total factor productivity (TFP). The results showed that effect of health on labor productivity was widely impressive and significant at the global level. Therefore, poverty and underdevelopment played a significant role in malnutrition.

Rivera and Currais's studies (2006) in different regions of Spain argue that current public expenditure on health could be viewed a policy option promoting economic growth and sustainable productivity. This finding indicate the impact of social infrastructure (health and education) on labor productivity compared to other infrastructure is more effective. Keimas et al. (2006) applied Johansen cointegration methodology and have conclude that in addition to GDP, population growth plays a key role in determining health care expenditures across many countries. Meanwhile, in Turkey, elasticity of health service expense with respect to income, was greater than one, as such it is considered as luxury goods.

Gyimah and Wilson (2004) examined effect of both investments in health human capital and capital stock on growth in selected sub-Saharan Africa and OECD countries in which both of them had positive and significant effect on growth and per capita income. Investment in health human capital increased directly and indirectly the steady state of per capita income level through promoting physical capital stock. Rivera and Currais (2004) indicated that public health had a different explanatory impact on productivity.

Bloom, Canning and Sevilla (2001) argued that health has a positive and significant impact on economic growth. Improvement in life expectancy by one year (health index) increases economic growth about 4 percent, but evidence did not support a finding on how education and experience affect economic growth. Arora (2001) demonstrated for a period of 100 years in ten industrialized countries that changes in health indices increased speed of growth from 30 to 40 percent and even changed trend of growth in long term. Interestingly enough, when health variable was controlled, investment in physical capital did have a significant bearing on growth rate. Kowles and Owen studied health capital and per capita income in different countries by applying a model developed by Mankiw, Romer and

Weil (MRW). It was indicated that there was a strong relationship between life expectancy (health capital stock) and per capital income. There was a weak relationship between education human capital and per capital income, while the existing research literature and theory do not support it.

To sum up, based on the previous studies one can strongly argue human capital, especially health, has a very important bearing on productivity and economic growth. The present article aims to introduce a new composite approach to measure the mutual impact of health and education on labor productivity.

3. Methodology

3.1 The Basic Model

In the theory of human capital, the more educated and healthy are more productive. Thus, the productivity of the labor force is driven by her status of health capital and education[1]. A healthy and educated work force is expected to contribute positively to the effectiveness and hence the productivity of a nation. So, our model is based on theoretical principles introduced by MRW model to examine the relationship between human capital (health and education) and labor productivity.

$$\ln Y_t = AK_t^{\alpha} H_t^{\beta} L_t^{\gamma} \tag{13}$$

The above equation is Cobb-Douglas production function that includes capital (K_t), human capital (H_t), labor (L_t) and technological process (A). There are several factors acting as determinants of labor productivity in macroeconomics i.e., capital/ labor ratio, human capital and capacity of technological process indexes that have been used in all studies in this field. The impact of human capital on labor productivity in long term is examined as follows.

$$Ln(Y/L)_t = Ln(A) + \alpha Ln(K/L)_t + \beta Ln(H/L)_t + \varepsilon_t \tag{14}$$

$$Ln(A)_t = \bar{A} \cdot \alpha_1 = \alpha . \beta_1 = \beta . \tag{15}$$

1. Kalemli-Ozcan et al. (2009)

It should be noted that in this study factors affecting labor productivity are estimated in steady state equilibrium. As mentioned above, if output per person employed is attributed respectively to physical capital (s_k= (K/Y)), human capital (s_h= (H/Y) with technological process (technical coefficient), then we will have the following equation in steady state as follows:

$$\mathrm{Ln}(Y/L)_t = \alpha_0 + \alpha_1 \mathrm{Ln}\left(\frac{s_k}{n+g+\sigma}\right) + \alpha_2 \mathrm{Ln}\left(\frac{s_h}{n+g+\sigma}\right) + \alpha_3\theta + \varepsilon_t \qquad (16)$$

In above equation, (Y/L_t) is output per person employed, taken as a proxy for labor productivity, S_k= (K/Y), ratio physical capital to output, S_h= (H/Y) ratio human capital to output. α_3 is equal to $\mu\gamma$. ε_t is a disturbing term. There are some parameters in the model viz: labor growth rate (n) in equilibrium steady state, technological process rate (g) and depreciation (σ). Thus, a general model can be written as follows:

$$\ln Y/L_t = \alpha_\bullet + \alpha_1 Ln(S'_k) + \alpha_2 Ln(S'_h) + \alpha_3\theta + \varepsilon_t \qquad (17)$$

According to this model, output per person employed depends on per capital stock, human capital and technological process.

3.2 Empirical Model

The empirical model for labor productivity in Iran is estimated on the basis of theoretical and empirical research. This study considers human capital (composition) once as a stock and once as a flow in two separately models.

First model, considers human capital as stock: (18)

$$\mathrm{Ln\,APL}_t = \theta_0 + \sum_{i=1}^{p}\alpha_i\ \mathrm{LnAPL}_{t-i} + \sum_{j=0}^{q_1}\beta_{1j}\,\mathrm{Ln\,(KL)}_{t-j} + \sum_{j=0}^{q_2}\beta_{2j}\,\mathrm{Ln(HC_{stocke})}_{t-j}$$
$$+ \sum_{j=0}^{q_3}\beta_{3j}\mathrm{Ln(CIRP)}_{t-j} + \gamma.X + u_t$$

Second model, considers human capital as flow: (19**)**

$$\operatorname{Ln} APL_t = \theta_0 + \sum_{i=1}^{p} \alpha_i \ \operatorname{Ln}APL_{t-i} + \sum_{j=0}^{q_1} \beta_{1j} \operatorname{Ln}(KL)_{t-j} + \sum_{j=0}^{q_2} \beta_{2j} \operatorname{Ln}(HC_{flowe})_{t-j}$$
$$+ \sum_{j=0}^{q_3} \beta_{3j} \operatorname{Ln}(CIRP)_{t-j} + \gamma . X + u_t$$

Abbreviations used in above equation are as follows:

APL: labor productivity or output per person employed as dependent variable

APL_{t-i}: lagged labor productivity in period i;

KL: ratio of capital to labor (capital per capita)

HC_{stock}: composition of human capital index (health and education stock)

HC_{flow}: composition of human capital index (health and education flow)

CIRP: ratio of actual output to potential output (capacity index)

α: coefficient of lagged independent variables

β: coefficients of independent variables

γ: coefficients of other exogenous variables

And θ: constant value of model

X letter is other exogenous variables including dummy variables.

It should be mentioned that applied dummy variable in general econometric models and in particular productivity model, is implied by shocks on variable in models, including structural economic changes and distortion term which altogether affect our estimations. Meanwhile, the index t, represent time and i and j index represent respectively lagged dependent and independent variables. All independent and dependent variables are treated in logarithmic form.

3.3 The Introduction of Variables

After having introduced abbreviations symbols above, now we attempt to explain how independent variables affect labor productivity as a dependent variable.

Before going to elaborate the findings, one should bear some points in mind: First, since each independent variables appears by its lag form in model, the overall effect of variable is counted on dependent variable. Second, number of lag period is determined by the model itself in its optimal way. Third, ceteris paribus assumption is applied in the analysis how the independent variables affect dependent variable in the model, Therefore, changes in independent variable depends on causal relationships and the overall effects of all independent variables.

3.4 Statistical Data, Definition and Sources

Different sources of statistics pertaining to 1974-2014 period were used in this research paper.

- Labor productivity (APL) is the ratio of GDP at 2010 constant prices (World Bank), to employment (Population and Housing Census by Statistics Center of Iran and Population and Management and Planning Organization).
- Capital per capita (KL) is the ratio of capital at 2004 constant price (Central Bank of Iran) to employment (Population and Housing Census, Statistics Center of Iran and Management and Planning Organization).
- Human capital (average of life expectancy of men and women) (World Bank -WDI).
- Human capital (average years of schooling for employees), bureau of macroeconomics, Management and Planning Organization, Iran.
- Human capital (ratio of total expenditure on health and education to GDP), Statistical Center of Iran, World Bank (WDI),
- Potential and actual output statistics for, World Bank (WDI).

3.5 Introduction to Human Capital Index

In empirical research, various indices are applied to measure human capital index such as: including average of academic year, government spending on education, government spending on health, infant mortality, average years of schooling, height index, body mass index, life expectancy, investment in health capital, investment in skills, longevity, educational levels and so forth. With a view to the importance of each of these indices and reducing the measurement error, four main indices in this studies were use as follows:

1- The life expectancy (men and women)
2- Ratio of total spending on health to GDP
3- The average years of education of employees (men and women)
4- Ratio of total spending on education to GDP

Indices 1 and 2 are related to health sector and indices 3 and 4 are related to education. Furthermore, to extend further the use of human capital it is necessary to develop a more “comprehensive index”. This index is a composite index that uses both health and education human capital in stock and in flow form. In the end this index was incorporated with Principle Component Method (PCM) and STATA software to calculate the comprehensive index.

3.6 Estimation Method and Tests

This paper employs the vector autoregressive technique with higher order-lag to eliminate the limitations of Engle-Granger method i.e. Biased sampling in small size and abnormal distribution of some least squares estimators. In this method, it is unnecessary to measure the reliability of variables in model through cointegration test.

By using Error Correction Model (ECM), short term variable fluctuations can be linked to long term equilibrium. Besides, diagnostic tests such as including heteroscedasticity test, normality test of residuals and test for the presence of autocorrelation are applied in order to ensure the validity of result. The advantage of ARDL method is that it examines the convergence between variables irrespective of reliability of independent variables. Generally for the calculation of the optimal number of intervals, the AKaike Information Criterion (AIC), Schwarz Bayesian Criterion (SBC) and R^2 are used.

Error correction term (ECT_{t-1}) is the same as error term in long run which is estimated by ARDL method. Its coefficient refers to speed of adjustment to long run equilibrium with expected negative sign with a value between minus one and zero. Obviously, it needs to fulfill the stationary and non-stationary test.

Therefore, the integration test indicates that there is a long run relationship between variables. However, only dependent variable is found to be non-stationary. Findings of our stationary test are depicted respectively in table (1) and Figure (1).

Table 1: Stationary and Non-stationary of Variables Based on Augmented Dickey-fuller Test (ADF)

Series status	Test of unit root(with intercept and trend)		Test of unit root(with intercept)		Test of unit root(without intercept and trend)		variable	Row
	t-statistic	prob	t-statistic	prob	t-statistic	prob		
non-stationary	-.73	0.35	-2.24	0.19	-1.87	0.65	LAPL	1
Stationary	0.59	0.84	-1.81	0.37	-3.90	0.02	LKL	2
Stationary	2.40	0.98	-7.62	0.00	-1.08	0.92	LHC1	3
Stationary	0.03	0.68	-1.68	0.43	-3.53	0.05	LHC6	4
Stationary	0.85	0.89	-4.77	000	-3.20	0.09	LCIRP	5

Source: Authors' findings

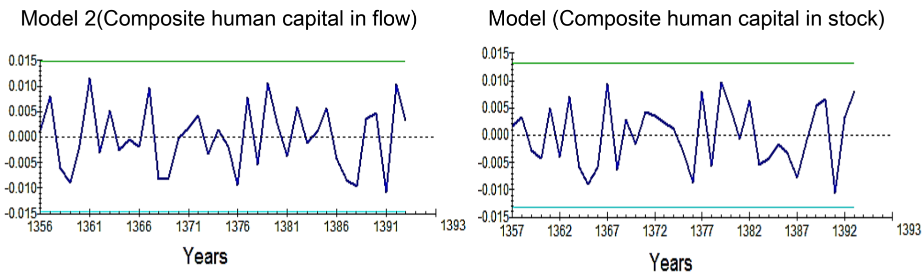

Figure 1: Plot of Residuals and Two Standard Error Bands

4. The Estimation Result Analysis

Here we present and analyze the results of dynamic models for short run and long run and at the end the estimation of equilibrium coefficient of error correction models (ECM) will be shown.

a) Labor Productivity with lag: The results of the estimation of dynamic models (APL) with lag can be shown in the table (2). It indicates that in both models in current period, there is a direct relationship between growth of labor productivity and its lag. It is theoretically acceptable. Findings indicate that coefficient of labor productivity with a lag (t-1) is significantly less than one but 0.6 in estimation models[1], therefore, it indicates that the model tends

1. $\frac{\text{CoefficientB} - 1}{\text{Standard deviationB}} = \frac{0.7 - 1}{0.049} = -5.3$

towards long run equilibrium. This reflects the fact that some part of changes in labor productivity in current year t, can be attributed to expectation in the previous year.

b) Per capita capital (ratio of capital to labor): According to findings of composite models, per capita capital has a direct and signification relationship with labor productivity. It means that increase per capita capital increases labor productivity. However, although the lagged variable with negative coefficient seems to be significant, but its obtained coefficient shows that an increase of 1 percent in per capita capital brings about 0.8 percent increase labor productivity in first model and 0.5 percent in second model.

c) Composite human capital index: Based on the result of composite index, increase in composite human capital (education and health) has a positive effect on labor productivity in Iran. Coefficients of models are significant and accord with theoretical framework and some empirical studies. Increase in composite human capital as stock by 1 percent brings about 1.64 percent increase in labor productivity and as flow it brings about 0.942 percent increase in labor productivity. Of course, in flow model, the coefficients of composite human capital is positive and non-significant, but in lagged flow model, the coefficients is positive and significant. To sum up, the effect of coefficients of model in stock form is greater than to that of the model in flow form.

d) Capacity index: This index in both models appeared had positive coefficient. As such it is considered as a capacity index, if the economy of Iran undergoes higher capacities, labor productivity (APL) will increase. An increase of one percent in capacity index is expected to raise labor productivity at least by 1.2% (in both models).

Overall, according to coefficients of model, impact of human capital especially human capital as stock, on labor productivity is more than that of other indices and it is of special importance to policy makers.

Results of ARDL estimation for labor productivity in Iran is depicted in table 3. According to the results of long term models, per capita capital has a significant and positive coefficient in two models (stock and flow). So, one percent increase in the amount of human capital both in stock and flow nature, boost labor productivity by 0.44

% and 0.28%, respectively. Capacity index coefficients are positive and significant in two models. Hence in the long run, infrastructural problems caused actual output fall below potential output, and it has a greater impact than per capita capital.

Table 2: ARDL Estimation Results of Labor Productivity Model in Iran (Dependent Variable: Log of Labor Productivity (LAPLS))

variable/ model	**Model (Composite human capital in stock)**	**Model 2(Composite human capital in flow)**
LAPLS(-1)	0.695 (9.76)	0.657 (9.09)
LAPLS(-2)	-0.233 (-3.25)	-0.076 (-1.06)
LAPLS(-3)	0.283 (5.03)	0.236 (4.35)
LKL	0.807 (5.36)	0.514 (3.55)
LKL(-1)	-0.273 (-1.36)	-0.462 (-3.59)
LKL(-2)	-0.422 (-3.24)	---
LHC_{stock}	1.643 (2.82)	---
LHC_{flow}	---	0.942 (0.035)
$LHC(-1)_{flow}$	---	0.131 (5.06)
LCIRP	1.269 (14.24)	1.204 (13.96)
LCIRP(-1)	-0.862 (-9.97)	-0.716 (-9.19)
intercept	-0.182 (-2.16)	0.0219 (0.274)
R^2 Adjusted	98.7	98.6
Lags	3	4

Note: The number in parentheses is the t- statistic.
Source: Authors' findings

With respect to human capital, the results of the two long term models suggest that the effect of composite human capital (flow and stock in nature), is positive and significant but effectiveness coefficient of composite human capital in terms of flow, is more than that of stock and their transition mechanisms for effectiveness are different. So , one percent increase in coefficient of human capital stock in long term, ceteris paribus, will increase labor productivity by 0.54%; however, impact of coefficient human capital(in terms of flow), on labor productivity is only 0.72% . This effect is revers in the dynamic model.

Table 3: Long Term Estimation Results of Labor Productivity Model in Iran (Dependent Variable: Log of Labor Productivity (LAPLS))

variable/ model	intercept	LKL	LHC_{stock}	LHC_{flow}	LCIRP
Model (Composite human capital in stock)	-0.713 (-2.05)	0.441 (3.19)	0.541 (4.11)	---	1.597 (3.87)
Model 2(Composite human capital in flow)	0.119 (0.270)	0.284 (1.41)	---	0.719 (3.57)	2.655 (3.95)

Note: The number in parentheses is the t- statistic.
Source: Authors' findings

The estimation of labor productivity model (APL), as mentioned earlier, revealed cointegration between a set of economic variables, as such, the Error Correction Model was applied. The major advantage of this model is that it takes into account short term fluctuations in variables the relationship between variable with their long run equilibrium amounts. In order to correct the error in equilibrium we have estimated ECM for APL which is corresponds to its estimation in dynamic ARDL. Estimation results is demonstrated in table 4. As mentioned before, the most important coefficient in this model is the coefficient of error correction variable (ECM t-1).

Table 4: Results of Labor Productivity Error Correction Coefficient (ECM) in Iran (Dependent Variable: Log of Labor Productivity (LAPLS))

variable/ model	dC	dLAPL1	dLAPL2	dLKL	dLKL1	$dLHC_{stock}$	$dLHC_{flow}$	dLCIRP	ECM(-1)	R^2 Adjusted
Model (Composite human capital in stock)	-0.182 (-2.16)	-0.499 (-0.87)	-0.283 (-5.03)	0.807 (5.36)	0.422 (3.24)	1.63 (2.82)	---	1.269 (14.24)	-0.255 (-6.03)	95.5
Model 2(Composite human capital in flow)	0.022 (0.027)	-0.159 (-3.03)	-0.236 (-4.35)	0.513 (3.55)	---	---	0.942 (0.035)	1.204 (13.95)	-0.184 (-4.67)	96.4

Note: The number in parentheses is the t- statistic.
Source: Authors' findings

As table 4 shows, coefficient of error correction model almost in all models is statically significant (in absolute terms) and is equal to 0.255 and 0.184 in both model respectively. It suggests that correction speed is moderate. The estimation of error correction coefficient suggest that at least 18% of disequilibrium will be corrected. To sum up, correction speed in these models is very slow. Besides, the short term disequilibrium converges to long term equilibrium after four periods of short term adjustment.

5. Conclusion

Health and education are not only beneficial in themselves, but they can be viewed as investments in human capital which lead to a higher future standard of living.[1] There is a general common sense about the constructive role of human capital in output and productivity growth. In the empirical studies, the performance of human capital is always measured by taking into account such consideration as education and other determining factors .the subject matter of output and productivity growth depends on human capital. Better education, more health, and new learning methods or educational skills is embodied in human capital stock. Such a view shows the importance of human capital (health, and education) in endogenous growth models.

In this paper, an attempt has been made to analyze the labor productivity effects of capital (education and health) in Iran. It deems important to examine different aspects of human capital (education and health), factors affecting the labor productivity growth. Empirical and theoretical studies in some countries show that in spite of the key role played by human capital in productivity and growth models, the result of models is subject to some limitations, because there is no consensus on indices selection. This paper having a wider view on human capital, and with employing a composite approach relying on the Principal Components Method (PCM), emphasizes on a comprehensive human capital index (health and education) for estimation of the per capita output growth model.

Our empirical model for labor productivity was estimated by expanding Solow model. This model benefiting from and theoretical

1. Schultz, T. Paul (1999).

studies has estimated the short and long term model for labor productivity. Moreover, two key factors determining labor productivity (capital per capita and capacity indices), parallel to composite human capital (flow and stock), were tested.

The results our models indicate that, the coefficients of all variables (except composite flow human capital) were statistically significant as expected sign in dynamic and long term models. The short run impact of composite human capital stock (health and education) is more than its flow term. But in the long term it is reverse. Therefore, in order to increase labor productivity and ensure a larger share of human resources in output and productivity growth, it is necessary to adopt a more appropriate policy to better allocation of expenditure on health and education (both for the government and the household sector) amid the structural and institutional shortcomings. The policy implications are that nations that desire high levels of per capita output and labor productivity can do so by increasing the stock of human capital, health human capital specially, particularly if their current stocks are low.

Therefore, the Iranian government needs to invest significantly on health capital. Also, the study essentially finds significant impact of the education-labor and health capital-labor interaction terms. This in essence signifies that the functioning of the labor force has a close link with education. This is because the supply of labor (demand for labor) to a large extent depends on the qualification acquired through education as well as healthiness, thus justifying increased budgetary allocations to health and education. This is because even when there is an increase in the productivity growth in response to the size of the labor force, it takes the educated and healthy, the (competent) to bring out the resourceful use of such labor services for greater productivity.

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