The Study Examining the Effect of Research Activities on Economic Growth: The Case of Iran

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Abstract: The education system in every country is a regular process and each year a big part of government budget and also private investments are allocated toward this system. In addition, some of the best years of every human are spent in schools and under education. Today, the economic effects of research are accounted as very important, because the relationship between level of education and income is proved to be positive. It means that educated people, in equal situation, will earn more money. More research makes people more skilled and these skills would lead to more production and service. So, in this study we will survey the relation between educated labors and economic growth in Iran. We showed that there's a long term relationship between these two, which is a positive and meaningful relation. In this study, we use production function (Feder, 1983), and also using auto regressive distributed lag (ARDL) co integration method, we will survey this long term relation, error correction model (ECM) and their dynamism effects. Most of past studies have used partial data (data from a certain time period); the problem with this method is that an average relationship is used, hence it won't yield any information more than what we just need. Only the studies by Love (1987) and Wilson (1994) have used time series in surveying this relationship. But, because most of the economic time series are non stationary, there is the possibility of artificial regression. In order to avoid the consequences, unit-root tests (Phillips-Perron & Augmented Dickey-Fuller) is used.

Keywords: *Research economic growth, Education, ARDL Co integration, Error Correction Model (ECM)*

1. Introduction

The importance of research in human life is so obvious that its role is prominent in every aspect of our life and is rarely doubted. More research makes people more skilled and these skills would lead to more production and service. This process will lead to an increase in producer's income, consumer's welfare, and consequently more Gross Domestic Product (GDP) and faster economic growth. Also, the more investment on research and development by a country, the more opportunities will arise and this will lead to more power in production and more income. Thus, these investments will bring about distributive effects and social justice. Also, considering the fact that technology transfer increase the pace of development in industries and pave the way for it, investment on research will lead to more industrial power and faster economic growth, undoubtedly. Iran is a developing country and always has tried to work toward the goal of a stable and long term economic growth, so any study on this matter is crucial for the country's economic growth. Besides that, because of country's population crisis and government's and families' attention toward investment on youth, and the importance of human resources in economic growth, it's very important to invest on youth education and its role on Iran's economic growth.

Since research is infrastructure development and it is the main basis for moving towards sustainable development, is described the importance of quality human resources in economic growth by endogenous economic growth models. Here, we have a hypothesis which: research has positive effects on country's economic growth. We use average years of education of a person as an index for human resource research.

Placing Human Capital in Production Function in Iran: Education, experience and health are three wings of human capital, and among these, education plays the main role. In contemporary literature of economics, "educational attainment" is used as an expression for educational wing of human capital. Human capital which is produced by education is an important element of development and economic growth. In order to acquire human capital, many indicators like (school) registration rate, literacy rate, population of researchers, engineers and technicians, education costs and average years of education (in school). Between these indicators, average years of is probably more important. In order to estimate the average years in school, lots of research has been done and from these, studies of Barro and Lee (2000) are the most detailed ones.

In order to study the effect of research on economic growth, between many approaches we can point out to the incorporation of human capital as the final product of education in production function. Experiences of developed countries show that explaining the economic growth merely based on physical capital and working population is wrong and not adequate. Besides these two, there are other elements which can reinforce the economic growth. These elements which are called surplus elements or remaining elements are the main reason for the increase in capital productivity and human resources. Many economists believe that surplus elements or remaining elements which explain a main part of economic growth in developed countries are directly or indirectly dependant on quality of education. So, human capital could be translated as the change in workforce quality along the change in education/experience level and according to this, production element is introduced in production function and increase the productivity above average. Also, human capital could lead to savings in foreign expenditures in production and again, leads to an increase in productivity of production elements.

Research in Economic: The current situation in underdeveloped countries is worrying, because the pace of progress in technology and science in developed/industrial country is very fast; hence the gap between these two groups is ever increasing. One of the most important elements of research in any country is human resources as researchers. This element is important, both from quantity and quality point of view. Today, more than 94% of research workforce is living in developed countries. Another important element is amount of investment on research and development. Investment on research plays an important role in economic-social-cultural growth of any country. If we look at the countries with fast development in past two decades, we will see that all of them have spent a significant amount on research. Economic-social-cultural growth, especially endogenous growth, needs a high level of activity in research fields. The problem is that developing countries have limited resources, so they can't vastly invest on research, and at the same time they need to invest on substructures beforehand which will bring about similar limitations. Today, underdeveloped countries lack sufficient space, equipment and academic bases, and even the existing resources in these countries need renovation and reconsideration. While developed countries don't have above problems and already ahead, they still allocate more and more attention toward research. Another element here is the share of research from GDP. While many developed countries allocate 0.5 to 1 percent of their GDP to research, in our country and in the best situation it has never crossed 0.5 percent and according to Iranian Central Bank, at its pick (2001) it was about 0.45% which declined to 0.31 in next year. After the Islamic revolution in Iran and in all of the years that economic-development-plans have been pursued, it has never crossed 0.35% (except 2001 and 2002); while in developed countries this figure is going toward 2%. For example the share of research from GDP in Germany is 2.41%, in Italy 2.21% and in Sweden is 3.76% (1997 numbers).

Iran's Position in World's Research Science Scene: In today's world of globalization, opportunities and chances are achieved for those countries which have enough power and proper strategies. One the decisive parameters of a country's power are it's scientific/research capacity. In order to assess this capacity in a country we will use science/technology indexes to do so. Science/technology indexes are a series of structured and quantifiable data which show the situation and the dynamic of a country in relation to Science/technology and its inner structure, linkage to foreign countries and realization of internal/external goals. If Iran wants to reach a proper position in the world, we must allocate a suitable amount of resources to research and science. The share of research budget from country's GDP is not better than 5% at its best; while this share was 82.2% in USA (1989) and 43.3% in Japan (1992). According to official data, the ratio of R&D budget to GDP in Iran is 0.32% which is a third of other developing countries and actually is less than most of the countries in the world except Africa. These figures show that how much we are behind from the world and even developing countries. Today, research and technologies set the balance of power in the world. In order to progress, we have no way but to accept the standard indexes of science and research and must find enough courage to confront our mistakes in our plans in this respect and work toward correcting them. If globalization means the extinction of different types of arts, costumes and traditions, we are facing our worst fears; but if globalization means finding new ways relationship and unanimity, it's a great achievement and must be cherished. If globalization is only as far as exchanging information and the product of globalization is only the faster access to raw material or consumer goods, then we shouldn't expect a bright future for the world.

2. Literature Review

Today, because of the important role of education and research on social and individual behavior and its effect on economic growth process, a new field in economics (as a science), called "educational

economics" has been established and has a fast development as a response to ever increasing demands of society in relation to education and research. Decision of some people toward more research, not only improves their own benefits but also other people. Michaelowa (2000) makes an example in which a farmer is educated to use new farming technologies; eventually his neighbors will follow him (after watching his improvement). Science which is based on watching is a process which will spread the benefits of research in society. The hypothesis that "investment on education leads to economic growth" goes back to Adam Smith era (classic economists). In that era, the stress was on investment on human skills. According to Smith (1776), human will evolve into capital by suitable education and this will lead to better service and production for the society.

Becker (1964) introduced his theory on human capital. According to his theory, accumulation of human capital is the engine of growth, such that the difference between countries growth is dependant on their difference in human capital accumulation through time. Nelson and Phelps (1966) tried to model the idea that "the main role of education is to increase people's capacity. An educated person is firstly an innovator and secondly will quickly adjust himself with new technologies and doing so will speed up spreading the technology in society. The result is faster higher productivity growth and innovation rate along with higher level of people's education. It's true especially according to the records of registration in high school and above, because the potential researchers are among these people. So in econometric models, in order to prove the effect of education on growth, registration in high school and above is used as an explanatory variable. Lucas (1988) introduced his theory of growth, based on Becker's human capital theory (1964). Lucas used a new structure of growth models which has concurrent effects on both physical capital and human capital. The nature of this concurrency is because of the effect of physical capital on human capital wages or human capital opportunity costs which are allocated to education sector.

Production of human capital is a good substitute for technologic developments and also a suitable deal for long term development. This theory was assessed by Lucas (1993) in East-Asian countries and is dubbed "great miracle" by him. In a study on convergence of growth in Canadian states, Coulombe and Tremblay (2001) used Barro & Sali model (1995) in which the full dynamic of capital in order to financially secure the human capital is assumed. Their findings show that accumulation of physical capital in Canada states (1951-1996) is a result of human capital accumulation process. The share of human capital variable in production is about 0.5. These results show that dynamic of human capital accumulation, leads to improvements in physical capital, income and production per capita. Bassanini and Scarpetta (2001) used DE La Fonte and Domenech (2000) and PMG procedure to make estimations for 21 country-members of OECD. They found a positive/meaningful relationship effect of human capital accumulation on countries' development. Also, they found out that by increasing a year in education, production per capita is increased about 6% in before-mentioned countries.

3. Methodology

Here, in our study we used the second approach and based on Feder's approach (using ARDL) we surveyed the effects of educated labor on economic growth. Feder divides the total production in economy in two parts: production for domestic market and production for exports. He shows that efficiency in exports sector is better than efficiency in non-exports sector.

$$Y = Y_D + Y_X \quad (1)$$

$$y_D = F(k_D, L_D, M_D, Y_X) \quad (2)$$

$$y_X = G(k_X, L_X, M_X) \quad (3)$$

This after summarizing the Feder's Endogenous growth model will be:

$$\dot{y} = \alpha \dot{k} + \beta \dot{L} + \phi \dot{M} + \theta \dot{y}_X \quad (4)$$

Now, after introducing Ln into the formula and dividing the exports into oil exports and non-oil exports, we have:

$$L_n(y_t) = \beta_0 + \beta_1 L_n(k_t) + \beta_2 L_n(h_t) + \beta_3 L_n(XO_t) + \beta_4 L_n(XNO_t) + \beta_5 L_n(M_t) + e_t \quad (5)$$

Here, Y_t is total production in economy, K_t is gross capital, H_t is educated labor average as researchers, X_{ot} is oil exports, X_{nt} is non-oil exports and M_t is imports. All the data have taken from Iranian Central Bank, Iranian Commerce administration and Iran's statistics center and are based on constant prices of 1997.

4. Results

Unit Root Test by Dickey-Fuller (ADF) and Phillips-Perron and the ARDL Co integration : In order to identify the stationary of the variables under study in this research, we start by applying the Augmented Dickey-Fuller (ADF) and Phillips-perron tests. The null hypothesis of a unit root is rejected if the value of the t-statistic for α (in absolute value) is greater than the critical value. From the results in Table 1, we find that the null hypothesis of a unit root cannot be rejected for any of the series (barring LM_t) at the 5 or 10 percent level.

Table 1: ADF and Phillips-Perron Unit Root Test Results¹

Variable	Constant(c) and trend (T) in the equation	ADF statistics	Optimal lag	Phillips-Perron statistics
$\ln Y_t$	C&T	-1.01	1	-1.73
$\Delta \ln Y_t$	C	-3.99*	0	-3.94*
$\ln XO_t$	C&T	-1.64	1	-1.83
$\Delta \ln XO_t$	C	-5.046*	0	-3.99*
$\ln XNO_t$	C&T	-2.16	1	-2.84
$\Delta \ln XNO_t$	C	-3.98*	0	-4.08*
$\ln H_t$	C&T	-1.27	1	-2.48
$\Delta \ln H_t$	C	-4.17*	0	-5.15*
$\ln K_t$	C&T	-1.19	1	-2.06
$\Delta \ln K_t$	C	-4.68*	0	-5.13*
$\ln M_t$	C&T	-5.39	0	-4.54*

The empirical results in table 1 show quite the opposite result after the first differentiating of the data where variables of the LY_t , LX_t , LH_t , LK_t become stationary and this means that all of these variables are $I(1)$ in log level and $I(0)$ after the first differencing. Thus, considering the fact that we have fixed and non fixed variables in the model, using ARDL co integration approach is the best solution. Besides, by repeating ARDL in the presence of several structural breaks we conclude that ARDL approach is meaningful at the structural break of progress in share of research from GDP in (2001), so we entered a dummy variable. Table 2 reports also the long-run coefficient estimates obtained from the version of the ARDL model.

Table 2: Estimated long-run coefficients

The long-run coefficients results ARDL (1,0,0,0,0,0)

Regressor	Coefficient	T-Ratio (prob)
$LXNO_t$	0.21	4.85 [.000]
LK_t	0.34	6.28 [.000]
LH_t	0.06	3.02 [.005]
LM_t	-0.21	-1.75 [.087]
LXO_t	0.058	1.93 [.061]
Intercept	7.94	3.6 [.001]
DU2001	0.095	2.6 [.013]

Also Table 3 reports the ECM coefficient estimates obtained from the version of the ARDL model:

¹ * indicates that, based on the MacKinnon (1991) critical values, the corresponding null hypothesis is rejected at the 5% significance level. The optimal lag length (k) is determined by the Schwarz Information Criterion (SBC). $\ln(Y_t) = \log(\text{economic growth GNP})$, $\Delta \ln(Y_t) = \ln(Y_t) - \ln(Y_{t-1})$, $\ln(XNO_t) = \log(\text{nonoil export})$, $\Delta \ln(XNO_t) = \ln(XNO_t) - \ln(XNO_{t-1})$, $\ln(XO_t) = \log(\text{Oil export})$, $\Delta \ln(XO_t) = \ln(XO_t) - \ln(XO_{t-1})$, $\ln(H_t) = \log(\text{educated labor average})$, $\Delta \ln(H_t) = \ln(H_t) - \ln(H_{t-1})$, $\ln(K_t) = \log(\text{total gross capital})$, $\Delta \ln(K_t) = \ln(K_t) - \ln(K_{t-1})$. (3) The data used in the present research are expressed in 1997 constant prices and have been collected from the Central Bank of Iran, and the International Financial Statistics (IFS) and statistic center of Iran and customhouse of Iran.

Table 3: Estimated error correction model (ECM)

Regressor	Coefficient	T-Ratio (prob)
DLXNO _t	0.04	3.79 [.001]
DLK _t	0.06	3.74[.001]
DLH _t	0.01	2.6 [013]
DLM _t	-0.04	-1.73 [.090]
DLXO _t	0.01	1.73 [092]
DC	1.63	3.04 [.004]
DDU2001	0.07	3.54 [.001]
ECM(-1)	-0.42	-6.56 [.000]
$R^2 = 0.99$ F= 2178.7 [000] D.W=2.03		

5. Conclusion and Recommendations

In this research at first we study variables Stationary and non-stationary by using from Dickey-Fuller (ADF) and Phillips-Perron, more than half of non-stationary variables with considering structural breaks show Stationary process. We found that the most significant structural breaks occurring over the last four decades and which were detected endogenously, in fact coincide with the progress in share of research from GDP in (2001). Human capital coefficient as researchers is positive and equal to 0.01 which shows that whit every percent increase in years of educated labor, economic growth will increase by 0.01 percent. The positive and meaningful effect of this variable on Iran's economic could be seen as the result of using technologies in industrial-agricultural-service-construction,... fields, and also partly as the positive result of research on productivity and production. This result is along with the positive and meaningful role of human capital as asserted in Endogenous economic growth models which are proved to be useful for Iranian economy.

Altogether, the results of this study show that average years of research in Iran has a meaningful and positive effect on country's economic growth. So it's only sensible to pay serious attention toward the quality and quantity of research in the country. This is even more important, when considering the increasing population of youth in Iran and the increasing need of our country to more progress and production. Government must allocate more budgets to research field in order to help this situation. Applying the ECM version of the ARDL model shows that the error correction coefficient, which determines the speed of adjustment, has an expected and highly significant negative sign. The results indicate that deviation from the long-term growth rate in economic growth is corrected by approximately 42 percent in the following year.

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