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Estimation of an Endogenous Economic Growth Model for Iran's Provinces

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Abstract: Currently, there is a large gap among economic growth rate of Iran's provinces. The various policies have been made to decrease this gap in development plans in the country. However, this problem has been intensified through using financial instruments such as special fiscal facilities. In this study, it is tried to identify the existing economic growth gap among Iran's provinces using Endogenous Growth Models. To do this, an Economic Growth Model for Iran's provinces has been estimated by Ordinary Least Squares (OLS) in a sample of pooled data. The estimation results show that human capital has the highest effect on economic growth among provinces. Also, the impact of human capital on economic growth among provinces having per capita income higher than average per capita income in the country has been greater than provinces having per capita income less than average per capita income in the country.

Key words: Endogenous growth, human capital, economic growth of provinces, Panel Data Model, income, Iran

INTRODUCTION

The widespread differences among various countries' economic growth rates resulted in major studies on the Growth Models. The initial researches assign the existing difference among growth rates to difference in basic production factors and technology. However, the modern theoretical and empirical studies indicate the internal factors and mechanisms of an economy (for example, human capital and R&D) as effective factors on economic growth besides physical capital and technology.

THEORETICAL AND EMPIRICAL BASICS

During the 1960's and 70's, the so-called Neo-classical Growth Model developed. Based on these models, the economic growth is affected by investment and the most determinant factor in the difference among GDP levels in the international context is physical capital. So, the faster and greater capital accumulation ends to high economic growth rate. Solow (1956) and Swan (1956) have suggested the above-mentioned models with the following assumption:

- A hypothetical economy consumes and produces only one homogenous good
- There is full employment in the economy

In the Solow-Swan Model, production function with two inputs, i.e., labor and capital has constant returns to scale and only capital can be accumulated.

The long-run growth path in the Neo-classical Growth Model is given using dynamic optimization and each household desires to maximize its utility regarding intergenerational responses. The major deficiencies of these models are the excluded technological changes and non-explaining the different residuals of growth sources among various countries. In response to above problems, Barro and Sala-I-Martin (1995) have designed the models that steady-state growth may achieved endogenously. In these models, the steady-state growth rate depends to parameters of utility function, production function and so on. The key feature of Endogenous Growth Models is lack of decreasing returns to scale. This property results in continuous and infinite growth.

HISTORICAL BACKGROUND OF CONTEMPORARY ENDOGENOUS GROWTH

The Endogenous Growth Theory originates from Adam Smith's thought about labor division in his seminal work, i.e., wealth of nations. Researcher begins his work by this statement that we may find some labor force to satisfy the small scale production of goods but they can not produce those products which should be consumed by many consumers. Researcher implicitly refers to improvement of labor skills, expansion and recovery of machinery in order to increase the labor productivity and advantages in time-saving. Babbage (1832) in his research on the economy of machinery and manufactures believes in decreased production costs and time-saving through labor division. Marshall in the principles of economics took a new step on the economic growth thought

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regarding mechanization and increasing the production capacities in a large scale. Based on his views, the usage of machinery in the production process becomes greater when labor division increases. Also with replacement of labor force by machinery, the desirability of large scale rather than small scale production creates high opportunities for workers. He discusses the limitation of using statistical assumptions about increasing returns to scale. In his viewpoint, the changes in supply affect on equilibrium and fixed supply is in contradiction with increasing returns to scale.

Sraffa (1926) in The Laws of Return Under Competitive Conditions believes in disinterest of some demanders relative to different products as an main obstacle of competitive game in market and concludes that increasing returns are seen in the special businesses with following assumptions:

- Free competition
- Minimization of consumption expenditure

Young (1928) in his book titled Increasing Return and Economic Progress emphasized to use indirect production methods such as specialization in manufacturing of intermediate goods. Kaldor (1961) in a study titled Economic Growth and Capital Accumulation presents a model for understanding economic growth and increasing returns to scale as a requirement for technological changes and specialization.

Arrow (1962) in his study titled The Economic Implications of Learning by Doing presented a model in which training is a production factor with positive effect on productivity.

CONTEMPORARY THOUGHTS IN ENDOGENOUS GROWTH

Now-a-days, economists pay attention to endogenous growth with emphasis on technological innovations and human capital and labor division. In this regard, Romer (1986) described Increasing Returns and Long-run Growth then he issued Growth Based on Increasing Returns due to specialization in 1987 and finally he wrote another paper titled Endogenous Technological changes in 1990. He refers to human capital as complementary factor in economic growth. In his view, human capital is the increased basic skills through education and training.

In the Romer (1994)'s Endogenous Growth Model, knowledge is a portion of capital stock of a firm and a public good that transfers among firms and finally it is available for consumers. In this study researchers summarize a two-sector Endogenous Economic Growth Model (Romer, 1990). This model has 3 main parts:

- Part 1 is research sector that uses only labor and produces with full employment
- Part 2 is related to intermediate goods that are produced in the full employment environment. In this part, capital goods and technology are used only for production
- Part 3 produces final output with full employment. The production function has standard Cobb-Douglas form

Total labor is composed of H_A (Labor for producing technology or knowledge stock i.e., A) and H_y (labor for producing final output i.e., y) so that:

$$L = H_A + H_y \tag{1}$$

In this model, the production function of final output is as follows:

$$y = Y(H_Y, X) \equiv H_y^{\alpha}\left(\sum_{i=1}^{\infty} x_i^{1-\alpha}\right) \tag{2}$$

In which x is an intermediate good. This function is homogenous of degree one and capital (K) is a combination of infinite kinds of durable goods, however a finite number of these goods (Intermediate goods are used for producing the final output in each period). So, researchers can write following relation:

$$K = \int_0^{A(t)} x(i)di = x^* A(t) \rightarrow x = \frac{K}{A(t)} \tag{3}$$

This means if researchers have not new technology then they will not give more capital. If researchers enter the x in the production function then they can write the following relation:

$$y = \frac{A(t)H_y^{\alpha}K^{1-\alpha}}{A(t)^{1-\alpha}} = (A(t)H_y)^{\alpha}K^{1-\alpha} \tag{4}$$

In which A(t) H_y is labor-augmented through technological changes. In the steady-state situation, the growth rate (g) is given by:

$$g = \frac{\dot{C}}{C} = \frac{\dot{y}}{y} = \frac{\dot{K}}{K} = \frac{\dot{A}}{A} = \delta H_A = \frac{(1-\alpha)\delta H_y - \rho}{1-\alpha+\sigma} \tag{5}$$

In which dot above the variables C (Consumption), y (Final output), K (Capital), A (Technology or knowledge stock) show the changes of variables with respect to time, δ, α, ρ, σ are depreciation rate of physical capital, input elasticity of H_y discount rate and preferences parameter, respectively. The implications of model are:

- The individuals having human capital allocate his work between research and production regarding knowledge stock (A), project price (P_A) and wage rate in production sector (w_A)
- The rate of return of human capital investment in the research sector is net future gain resulting from project. So, the net present value of project will decrease if the interest rate is high and less human capital will be allocated to research sector and this process will decrease the growth rate
- Any changes in parameters δ, α, ρ and σ will change the magnitude of growth rate
- Increased human capital raises the growth rate

In this model, the return of human capital in research sector is increasing, so with increases in A and H in the first phase, marginal product of human capital will rise in research sector in the next phase, marginal product of physical capital in the final output sector will increase through spillover effects of research and development. Thus, the economies having high human capital and knowledge stock will experience fast and high economic growth rate.

EMPIRICAL STUDIES RELATED TO HUMAN CAPITAL AND ENDOGENOUS GROWTH

Schultz (1971) believes in human capital as an effective and important factor on economic growth. In his formulation of economic growth, the terms inside the parentheses show the share of labor quantity and the terms inside the brackets show the share of labor quality in economic growth:

$$G = \sum_{n=1}^{n} g_n s_n = \left(g_0 \frac{l_0 w_0}{y} + g_1 \frac{l_1 w_0}{y} \right) + \left[g_0 \frac{l_1 (w_2 - w_1)}{y} + g_2 \frac{l_2 (w_1 - w_0)}{y} \right] \quad (6)$$

In which G is total growth rate, g_0, g_1, g_2 are growth rate resulting from l_0, l_1, l_2, respectively w_0, w_1, w_2 are wage rate pertaining to those levels of labor. He used this method for Hawaiian economy over the 1950-1960 and concluded that about 31.27% of its economic growth rate is pertinent to quality improvement of labor in that period. Mankiw *et al.* (1992) used the enrolment rate in tertiary schools as a proxy for human capital and estimated the following relation:

$$Ln(y) = A + \alpha_0 \ln\left(\frac{I}{Y}\right) + \beta_0 Ln\left(\frac{I_n}{Y}\right) + \gamma_0 L(N) \quad (7)$$

and concluded that coefficient of human capital investment (In) is almost equal with coefficient of physical capital investment (I), i.e., $\alpha_0 \cong \beta_0$.

In the mentioned model, y and Y are per capita and total output, N is total labor force, Ln is symbol for natural logarithm and A, α_0, β_0, γ_0 are parameters. Komeijani and Memarnejad in a study about the impact of labor quality on economic growth in Iran over the period 1958-1999 show that human capital has significant and positive effect on economic growth in the short-run also in the long-run.

MODEL SPECIFICATION

With regard to title of the study and consideration the theoretical basics and empirical background, two models are introduced as follows:

$$Gy_{it} = \alpha_0 + \alpha_1 LGK_{it} + \alpha_2 GL_{it} + \alpha_3 GH_{it} + \alpha_4 NP_{it} \quad (A)$$

$$LY = \alpha_0 + \alpha_1 LL + \alpha_2 NP + \alpha_3 LH \quad (B)$$

Where:

i = Province
t = Time
Gy_{it} = The growth rate of real per capita GDP of each province
LGK_{it} = The growth rate of physical capital stock. Due to lack of data about provincial physical capital stock, researchers used relative governmental capital expenditure in each province as an indicator for GK_{it}
GL_{it} = The growth rate of employed labor share (from population) in each province
GH_{it} = The growth rate of number of high school students in each province (as a proxy for human capital)
Np_{it} = Inflation rate in terms of changes in Consumer Price Index (CPI)

In Model B, logarithm of output is dependent variable and logarithm of labor, logarithm of human capital and inflation rate are independent variables. Model A is estimated using GLS+fixed effects with panel data (pooling of time series data over the 2000-2002 and cross

Table 1: The regression results for Model A

Variables	Coefficients	SE	t-statistic	Prob.
GL_{it}	0.046955	0.044839	1.047190	0.2982
GH_{it}	0.660428	0.059000	11.19379	0.0000
NP_{it}	0.522996	0.160412	3.260333	0.0016
LGK_{it}	0.037797	0.017529	2.156275	0.0341
Fixed effects				
ASH_C	0.787060	-	-	-
AGH_C	0.752948	-	-	-
AR_C	0.665262	-	-	-
ESF_C	0.767105	-	-	-
IL_C	1.073788	-	-	-
BOU_C	0.900130	-	-	-
TEH_C	0.887495	-	-	-
CHA_C	0.684282	-	-	-
KHO_C	0.780426	-	-	-
ZAN_C	0.637345	-	-	-
SEM_C	0.692773	-	-	-
SIS_C	0.675956	-	-	-
FAR_C	0.808710	-	-	-
GAZ_C	0.453797	-	-	-
GOM_C	0.704430	-	-	-
KOR_C	0.687498	-	-	-
KER_C	0.636177	-	-	-
KERSH_C	0.709572	-	-	-
KOH_C	0.573550	-	-	-
GOL_C	0.692444	-	-	-
GIL_C	0.744976	-	-	-
LOR_C	0.696816	-	-	-
MAZ_C	0.845011	-	-	-
MAR_C	0.774260	-	-	-
HOR_C	0.676944	-	-	-
HAM_C	0.811466	-	-	-
YAZ_C	0.760361	-	-	-

section data for 28 provinces of Iran). Model B is estimated using OLS Method. Table 1 shows the regression results for Model A.

In Model A, coefficient of LGK (Growth rate of physical capital stock) is significantly positive with one lag, coefficient of GL (Growth rate of employed labor share) is positive but insignificant, coefficient of NP (Inflation rate) is significantly positive and GH (Growth rate of human capital) has more positive effect on economic growth rather than GK (Growth rate of physical capital). Since, the effect of human capital on economic growth may be different among provinces with different per capita income, so researchers divide total provinces into two groups; those have per capita income less than average per capita income in the country and those have per capita income higher than average per capita income in the country. Of course, average per capita income in the country is about 1564$ with exchange rate 1$ = 8000 Iranian rial over the study period.

Because of low being the number of provinces having per capita income higher than average per capita income in the country, researchers used cross section data for 2001 (Saadat, 2006) and definition of dummy variables for estimation the Model B. In this estimation, LY, LH, LL, DP and NP are logarithm of real output (GDP), logarithm of average of human capital, logarithm of labor, dummy variable and inflation rate, respectively. DP = 1 for provinces having per capita income less than average per capita income in the country and DP = 0 for provinces having per capita income higher than average per capita income in the country. The regression results using OLS estimation and dummy variable are shown in Table 2. Based on regression results, the most positive effect on economic growth is due to human capital. Also, the negative coefficient of dummy variable shows that human capital in provinces having per capita income less than average per capita income in the country has less effect on economic growth in those provinces.

Table 2: The regression results using OLS estimation and dummy variable (LY is dependent variable)

Variables	Coefficient	SE	t-statistic	Prob.
C	-11.286720	3.458567	-3.263410	0.003600
LL	0.502702	0.130838	3.842186	0.000900
NP	-0.011313	0.005219	-2.167573	0.041300
LH	0.994720	0.331828	2.997702	0.006600
MA (1)	-0.971824	0.048179	-20.171050	0.000000

R^2 = 0.871508; Mean dependent var. = 4.491568; Adjusted R^2 = 0.842306; SD dependent var. = 0.871592; SE of regression = 0.346115; Akaike info criterian = 0.903320; Sum squared resid = 2.635508; Schwarz criterian = 1.188792; Log likelihood = -6.646478; F-statistic = 29.843500; Durbin-Watson stat = 1.607406; Prob (F-statistic) = 0.000000

Table 3: The regression results using OLS estimation (LY is dependent variable and DLH = Dummy*LH))

Variables	Coefficients	SE	t-statistic	Prob.
C	-10.284730	3.672673	-2.800340	0.010400
LL	0.586704	0.125270	4.683509	0.000100
NP	-0.004850	0.010111	-0.479643	0.636200
LH	0.722604	0.306897	2.354549	0.027900
MA (1)	-0.607200	0.219505	-2.766229	0.011300

R^2 = 0.859762; Mean dependent var. = 4.491568; Adjusted R^2 = 0.827890 SD dependent var. = 0.871592; SE of regression = 0.361589; Akaike info criterian = 0.990795; Sum squared resid. = 2.876432; Schwarz criterian = 1.276267; Log likelihood = -7.871123; F-statistic = 26.975340; Durbin-Watson stat = 1.932026; Prob (F-statistic) = 0.000000; Inverted MA roots = -61.000

In order to consider the effect of human capital on economic growth in provinces with low and high per capita income, researchers define another dummy variable as DLH = Dummy*LH. By this definition, the regression results of OLS estimation are shown in Table 3. Since, DLH is significantly negative and dummy variable = 1 for provinces with low per capita income, researchers conclude that the effect of human capital on economic growth in provinces with high per capita income is greater than those with low per capita income.

CONCLUSION

The most important effective factor on economic growth among Iran's provinces is quality of labor. The increases in human capital indicator results in improvement of quality of labor and increases of growth

rate. Inflation rate regarding price expectations of workers in the study period gives rise to positive effect on economic growth. The effect of lagged governmental capital expenditure is relatively positive in the study period. Human capital has more effect on economic growth in provinces having per capita income higher than average per capita income in the country.

To summarize, for decreasing the economic growth gap among regions is not sufficient usage of financial and finance instruments and technology. Using internal factors and mechanism (for example, human capital and R&D) can affect the economic growth to large extent and reduce the inequality intensity among regions.

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