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The Investigation of Effect of R&D on Total Factor Productivity in Iran

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ABSTRACT

There are many methods for investigation of total factor productivity. In this paper, research and development effect on total factor productivity using divisia index have been applied. This research has established annually data for 1979-2009 (1358 – 1388 in Persian date) using Auto Regressive distributed Lags (ARDL). Results showed that production function is decreasing returns to scale in Iran and R&D has positive significant effect on total factor productivity.
KEY WORDS: Research and Development, Total Factor Productivity, Decreasing Returns to Scale, Auto Regressive distributed Lags (ARDL)

1. INTRODUCTION

Productivity is the very important key of every economy that has in flounced rule in the vast areas of micro and macro economics. In contrast to most studies of productivity movements, this study investigates what factors explain productivity movements when labor and capital are changed. In addition to the roles of production factors, we test for the effects of two interesting Variables (R&D and Human Capital) on changes in total factor productivity in Iran Economy. The first variable is more important, because in most countries, this variable have significant effect on economic growth; especially in developed countries this effect is most highlighted. In this regard investigating of research and development expenditures on productivity in a developing country such as Iran is interested and is the fundamental aim of this research. Also various kinds of supply side policy have much different effect on productivity. Under this production factors arrangement, we first should calculate total factor productivity using these factors. In addition, studying the productivity movements is more interesting when one knows that the Iran economy is as fluctuate economy that depends on oil incomes and these earnings have direct affect on employment and capital movements. A system driven by marketing is one that puts the customer needs first, and only produces goods that are known to sell. Market research is carried out, which establishes what is needed. If the development is technology driven then it is a matter of selling what it is possible to make. The product range is developed so that production processes are as efficient as possible and the products are technically superior, hence possessing a natural advantage in the market place (Craig and Harris, 1973). So in this article effect of R&D on total factor productivity is investigated. In this regard in section two, literature review is represented, in section three, methodology and data are applied. In section four results are obtained and finally section five is paper's conclusion.

2. LITERATURE REVIEW

Productivity level are: Single factor productivity (SFP) defined as the ratio of a measure of output quantity to the quantity of a single input used, Labor productivity (LP) defined as the ratio of a measure of output quantity to some measure of the quantity of labor used, such as total hours worked, Multifactor productivity (MFP) defined as the ratio of a measure of output quantity to a measure of the quantity of a bundle of inputs often intended to approximate total input and, Total factor productivity (TFP) defined as the ratio of a measure of total output quantity to a measure of the quantity of total input (Kurosawa, 1975). Most of the usual productivity growth measures can be defined in terms of the growth or change from s to t in an associated productivity level measure, where t denotes the production scenario of interest and s denotes the comparison scenario. All of the productivity indexes we consider have some measure of output quantity or change in the numerator and some measure of input quantity or change in the denominator. A key issue in the construction of variables of input and output quantity is that they should only change in response to changes in quantity (Loggerenberg and Cucchiaro, 1982).

Lehtoranta (1998) estimates a firm level random effect using data for 186 Finnish firms over the period 1991-1994. This is a period characterized by low or negative growth in the Finnish economy. In accordance with the arguments above, the estimations show that the elasticity of R&D capital on labor productivity is about 0.07. Mairesse (1990), Hall and Mairesse (1995), Wakelin (1998) and others uses firm data. These studies present

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evidence for France, the United States, Japan and Belgium. The estimated rates of return lie between 0.2 and 0.5, but it should be noted that the rate of return depends on the unit values of R and Y. In general, however, there seems to be only minor indication of significantly higher rates of return in the studies using industry data as compared to individual firm studies. Wakelin (1998) focuses on differences between innovators and non-innovators, with the R&D having the largest productivity effects for the latter group. Furthermore, sector-specific effects are controlled for in order to reduce the bias due to sector- specific un-observables. His main conclusion in Pakes and Griliches (1984) is, however, that there is a strong and positive relationship between R&D and the number of patents at the firm level in cross-section studies. More precisely, if the firm has made a success of its R&D investment by being more innovative, higher overall productivity should be expected. Consequently, the interaction of R&D and innovation is likely to have a positive effect on productivity.

3. METHODOLOGY AND DATA

In this research, Auto Regressive Distributer Lags (ARDL) is established. In this approach, integration of variables is not important and model is estimated regardless of stationary or non-stationary of variables. Also lags of variables have most important roles in model estimation process. The ARDL approach involves two steps for estimating long run relationship (Pesaran et al., 2001). The first step is to investigate the existence of long run relationship among all variables in the equation under estimation. This step is known as short-run relationship between variables or short-sun estimation. In this step lags of independent and dependent variables are presented in right side of model as well as current amount of independent variables. The second step is to estimate the long-run relationship and short-run bi-directional causality between running actors. We run second step only if we find a long run relationship in the first step (Narayan et al., 2005). In this step, long-run relationship between variables is established. In other words, long-run model let us to judge about actual relationships between this research's variables. This study uses a more general formula of ECM with unrestricted intercept and unrestricted trends (Pesaran et al., 2001). The model can be selected using the lag length criteria like Schwartz-Bayesian Criteria (SBC) and Hannan-Quinn (HQ) information criterion.

The model used in this case is as below:

$$TFP_{it} = \beta_0 + \beta_1 LRD_t + \beta_2 LH_t + \varepsilon_{it} \quad [1]$$

In equation [1], TFP is total factor productivity, LRD is research and development expenditures in logarithm term, LH is logarithm of human capital. TFP is calculated using divisia index as below.

$$TFP_{it} = \frac{GDP_t}{L^{\alpha}.\ K^{\beta}} \quad [2]$$

In equation [2], GDP is gross domestic production, L is labor force and K is capital. For abstaining α and β we established below regression:

$$LGDP_{it} = \beta_0 + \beta_1 LL_t + \beta_2 LK_t + \varepsilon_{it} \quad [3]$$

4. RESULT

Before estimation the model, stationary or non-stationary of variables should be determined. Paper starts by testing the hypothesis that each series contains a unit root. For this aim, augmented Dickey-Fuller test is applied that procedure by trying two different tests in which I include trend and intercept in the first test and only an intercept in the second test. These tests are performed on the levels and on the first differences as shown in Table 1.

Table 1: Tests for Stationary

Variable	T-statistics Levels	First Difference	Lags	Classification
Augmented Dickey-Fuller Test				
Test Assumptions: Intercept*				
LGDP	-1.7427	-5.6487	3	I(1)
LL	-0.6570	-5.3482	3	I(1)
LK	-1.9413	-6.0074	3	I(1)
LRD	-1.9067	-5.9859	3	I(1)
LH	-4.7427	--------	3	I(0)
Test Assumptions: Intercept and Trend**				
LGDP	-1.6591	-6.0143	3	I(1)
LL	-1.5637	-5.2412	3	I(1)
LK	-1.6492	-6.1203	3	I(1)
LRD	-2.7209	-4.2766	3	I(1)
LH	-3.6591	--------	3	I(0)

* 5% critical value =-2.7981
** 5% critical value = -3.4409

Four variables are not stationary in levels. These variables are gross domestic product, labor force, capital and research and development expenditures. In this step, model [3] for deriving TFP has been estimated. Results present in table 2.

Table 2: Production function Regression Estimation Result

Variable	Coefficient	t-Statistic – Prob
LL	0.411	4.3103 [.000]
LKP	0.524	5.0374 [.000]
C	0.015	2.3335 [.032]

R^2= 0.974 D.W. = 2.03

Due to the result of table1, we show that α=0.411 and β=0.524 and hence production function is decreasing returns to scale. In next step TFP is calculated using divisia index (see equation 2). Figure of TFP trend is showed in figure1.

Figure1: Calculated TFP using divisia index

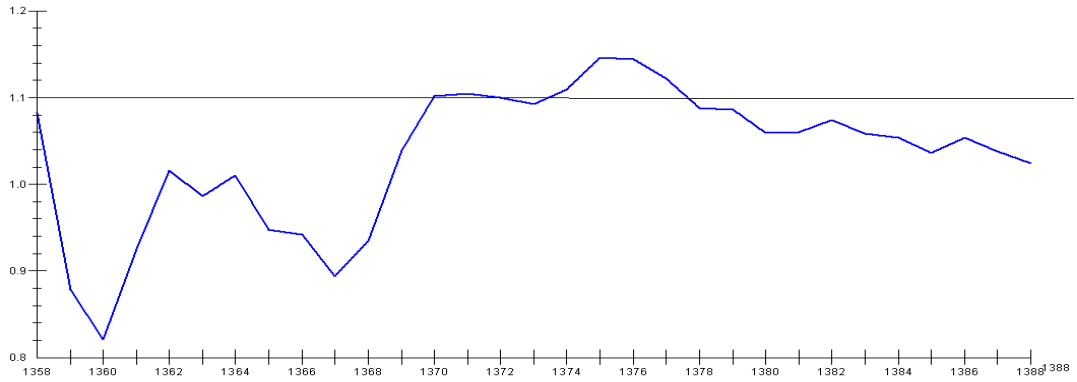
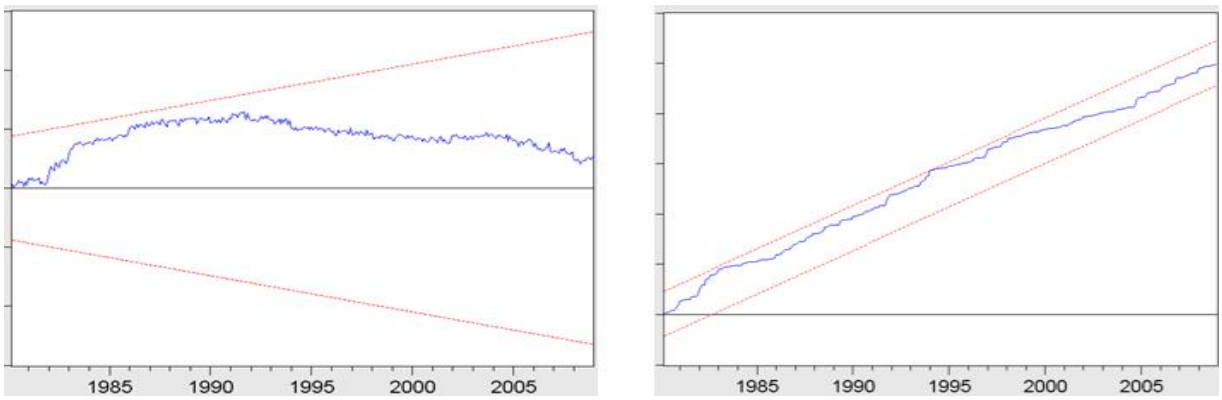


Figure2: CUSUM and CUSUMSQ tests for stability of TFP



We show that this model is stable.

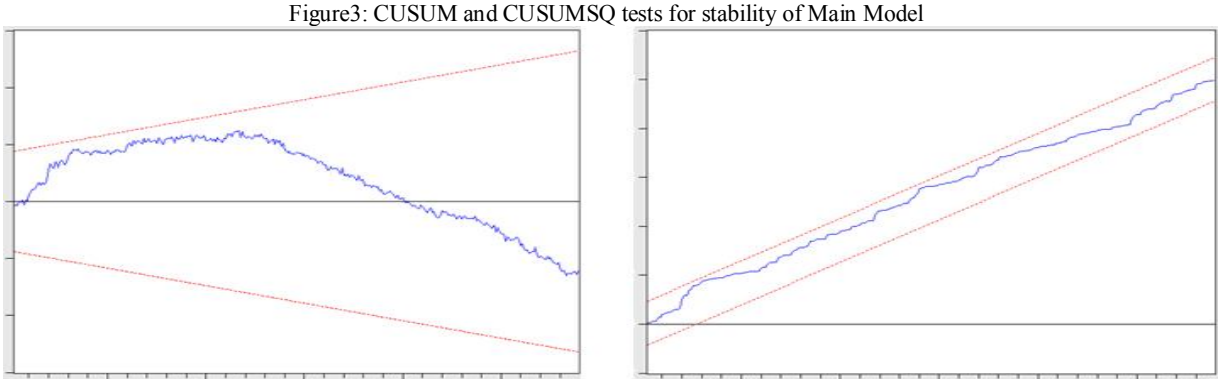
Final step is estimation of regression function with TFP as dependent variable and R&D and human capital as independent variable. Results are shown in table3.

Table 3: Long-run Estimation Result

Variable	Coefficient	t-Statistic - Prob
LRD	0.011	3.1905 [.005]
LH	1.538	7.4553 [.000]
C	0.007	.41669 [.682]

As we seen, Results showed that R&D and human capital have positive effect on TFP in Iran.

Figure3: CUSUM and CUSUMSQ tests for stability of Main Model



Also, in this model we show the stability of main model.

5. Conclusion

The aim of this research is to investigate relationship between TFP and R&D expenditures. There are many methods for investigation of total factor productivity. In this paper, research and development effect on total factor productivity using divisia index have been applied. This research has established annually data for 1979-2009 (1358 – 1388 in Persian date) using Auto Regressive distributed Lags (ARDL). The ARDL approach involves two steps for estimating long run relationship. Results showed that production function is decreasing returns to scale in Iran and R&D has positive significant effect on total factor productivity. Also positive effect of human capital on TFP is another result of this research.

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