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Identifying the effect of Research and Development on Total factor Productivity of Iranian´s Manufacturing Sector: 2001-2007

Farhad KhodadKashi

PHD, Associate Professor of Economics Department, Payam Noor University 19395-4697, Tehran, IR of IRAN

Email: khodadad@pnu.ac.ir

Mahdieh MehdizadehShahi…(Corresponding Author)

Master´s degree in Economics of Economics Department, Payam Noor University 19395-4697,Tehran, IR of IRAN

Email: economy84.m@gmail.com

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Abstract:

This paper is to investigate the effect of research and development on total factor productivity at the level of manufacturing sector of Iran during 2001-2007. We have used translog production function. The results indicate that research and development has a positive and insignificant impact on productivity. We find that the production function isnot a cob-douglas one and also the return of scale in manufacturing sector of Iran is increasing. This insignificant relationship can be explained by the gap of R&D expenditure ratio between Iran and other countries. According to the little R&D expenditure impact on productivity in manufacturing sector, Policymakers must pay more attention on R&D activities in Iran.

Keywords: Research and Development, Total Factor Productivity, Manufacturing sector, Panel Data, Translog Production Function.

1. Introduction

One of the most important issues in Iran's economy is low productivity. It can be cuasd by not using existing capacities in manufacturing sector of Iran. Research and development activities can increase productivity and also improving the quality of capital, human capital and technological improvement can increase productivity. In knowledge-based economy research and development activities are partial of investment in different levels.

According to importance of productivity in the economic, social and cultural development plans and high share of productivity in manufacturing sector, policy maker must pay attention

on increasing productivity. We know productivity and it's changes are affected by different factors; for example R&D activities and progression technology lead to increase productivity.

Schumpeter (1942) believed R&D has high effect on innovation that makes to increase productivity and economic growth

Research and development (R&D) is a concept seriously discussed only since 20s century; until WWII, R&D activities were only focused military manufactures of USA, Japan and EU. After WWII, by investment on results from R&D, USA attained to increasingly improvement of new products. One of the power tools indeed means attaining to manufacturing development followed by economic development of society.

In today's developed world, scientific evolutions have been accelerated such that in any time we encounter with a mass of new findings. This may not be attained only by allocating more resources in the field of R&D in the organization. In studies conducted for situation of R&D in Iran during the years of implementing the economic, social and cultural development plans, policy maker focused on researching activities with increased credits for it. The importance of R&D is to such extent that countries are grouped into two, developed and non-developed, based on the ratio of researching budgets to national gross income (Jalalabadi, 2004). In economic theories, there has been mentioned the influence of R&D activities on economic development.

This study deal with Iranian manufacture in the framework of productivity in this section and intended to study the role of R&D on total factors productivity in Iranian Manufacture. For fulfilling this objective, there are used raw data of statistical plans of manufacturing workshops in Iranian manufacture sector by Statistics Center.

This paper has been prepared in five sections. After introduction, in the second section there has been studied the theoretical basis and background, third section provides a review on R&D in Iran; fourth part deals with data and estimation of model and fifth part is conclusion. In this study, for investigating the role of R&D expenditures on productivity, there is used Translog Production Function. By modeling the Translog Production Function, coefficient of production are calculated by E-views Econometric Software.

2. Literature Review

Today in all developed and or developing countries, there are concentrated on the importance of productivity as one of the necessities of economic development and attaining the competitive priority in international areas; because in modern day, competition in global area provided other dimensions and attempting for achieving higher productivity level forms one of the main bases of these competitions.

In our country, importance of productivity due to different reasons such as no accurate culture and view on productivity in society was ignored and despites some actions taken such as establishing the national productivity organization and some stresses in the third development plan related to promoting the productivity, there is yet more distance attaining to suitable situation and it is necessary to gait in such field (studying the productivity in Iranian Economy, 2005, Central Bank). In this study, using productivity index of total production factors, the combined productivity of all data are calculated and thus there is prevented from complications formed due to considering only one factor.

2.1 Relation between R&D Expenditures and Productivity

According to considerable contribution of productivity from economic development in economic, social and cultural development plans, the most important factors influencing on

productivity includes cases such as foreign investment, R&D, commercial policy and training as well as education of labor force.

In endogenous growth, by its effects on technology and production, R&D will evolve production processes on one side and by influencing on reduced cost of production factors may improve productivity development on the other side. In R&D based models, technological development by investment will influence on R&D and creating new thoughts (Amini, 2008).

Related to developed innovation and manufacturing area, Schumpeter articulated its theories in such manner if a concentrated market structure will provide a better environment for developing new innovations than competitive market and if institutes have higher contribution from R&D activity market?

In the opinion of Schumpeter, the benefits of R&D activities are in higher institutes than small institutes. According to Schumpeter, implementing the innovative activity is more effective by exclusive institute or multi-exclusive institute. Institute with higher contribution will attain higher benefits and is more effective by development of new technology and products (Cohen & Levin, 1989).

2.2 Previouse works

- 2.2.1 International Studies

Bart Verspagen studied the differences between sectors and countries according to the relation between productivity development and R&D. in his study, he used Translog production function for estimating R&D contribution for economic development such that:

$$lnY = A + \alpha_L lnL + \alpha_K lnK + \alpha_R lnR + \alpha_T T_t + \frac{1}{2}\alpha_{LL}(lnL)^2 + \frac{1}{2}\alpha_{KK}(lnK)^2 + \frac{1}{2}\alpha_{RR}(lnR)^2 + \alpha_{TT}T^2 + \alpha_{LK} lnL\ lnK + \alpha_{LR} lnL\ lnR + \alpha_{LT} \ln L.T + \alpha_{KR} lnK\ lnR + \alpha_{KT} \ln K.T + \alpha_{RT} \ln R.T \quad (1\text{-}2)$$

Where, T is for time comprising all technological changes not considered in the model, Y is output, L is labor, K is capital stock, R is R&D stock.

In this study, parts have been divided based on R&D rate on value added of the same part into developed technology, average technology and low technology and it is positive and significant in the relation between TFP and R&D accumulation in developed technology part.

In a paper by Mark Rojer (2009), called "Productivity and R&D: Using UK firm-level data to inform policy" during 1989- 2000, it deals with analyzing the relation between productivity and R&D based on data provided from 179 big institutes in UK. This study deals with Cub-Doglass production function to express the relation of investment in R&D and value added of institute by a logarithmic differential of this function:

$$Yit=\Delta\beta t+\Delta\alpha+\alpha 1\Delta nit+\alpha 2\Delta kit+\alpha 4.RDit/yit+\Delta uit \quad (2\text{-}2)$$

Where; Y is value added; A is all external effects of knowledge; K is physical capital; R is R&D; N is labor and α_4 is R&D coefficient for output growth rate. In this study calculations conducted by OLS method and results indicate that R&D output in UK, on 90's were relatively stable.

- 2.2.2 National Studies

In a study by Amini and Hejari Azad, "Analyzing the role of human capital and R&D in promoting the productivity of total factor productivity (TFP) in Iranian economy", they

investigated the factors influenced on total productivity of production factors stressing on the ratio of employed people with higher education as replacement of human capital of type of training, public R&D capital, ratio of actual and potential production as the index of rate of using the capacities. Finally, according to hypotheses, TFP is clarified as below:

$$Log(TFP)=0/268log(KR\&D)+0/057LHE+0/61log(UR)-0/042T-0/102D_{60}+0/88D_{53}-0/043DW \quad (3\text{-}2)$$

TFP: Total Factor of Production, KR&D: public research and development in fixed price on 1998, LHE: ratio of employed people with higher education as replacement of human capital of training type; UR: ratio of actual and potential production multiply by 100 as index of productivity rate of capacity and T: variable of time trend as replacement of other factors influencing on productivity and three virtual variables, D_{60}, D_{53} and DW, effects of shock of beginning the forced war in its first year (for 60 for one and other years, zero), effects of oil shock of 1973-74 and negative effects of forced war on Iran in 1980-1988.

When estimating the model using time series data of 1968- 2004 by self-explanation model by extended pauses (ARDL) indicates that in long term the public R&D capital, ratio of employed people with higher education and rate of productivity from capacity had positive and significant effects on productivity.

Jalalabadi (2001) studied the role and effect of researching expenditures on economic development in Iran in the framework of R&D based endogenous economic development models during 1970- 2000. Theories of this study includes investigating the significance of relation between development of researching expenditures and growth of gross domestic production as well as studying the positive relation between researching expenditure and economic development.

3. R&D in the World and Iran

R&D is a concept that has been only discussed since 20's seriously. Until WWII, R&D activities were mainly concentrated in military industries of USA, Japan and EU. In those years, issues were dissolved in two levels, organizational and national by providing an alternative and investment on it. Researching institutes were usually small with no complicated management. Consequently, encountering with R&D activities with other factors was simple and after WWII, by investment on resulted from R&D, USA increasingly improved its new products. Indeed, one of the power tools was considered as achieving manufacturing development and then economic development in the society. In addition, the rate of capital allocated to R&D by industries, indicates the rate of progress by that manufacture.

On 2005, total R&D of OECD countries was 2.3% of their Gross Domestic Development. By attaining technical knowledge and transaction technologies, most countries attain highest incomes in international arena. R&D costs through the world is at least 729 billion Dollars, half of which expended by two main countries, i.e. USA and Japan. R&D cost for OECD countries on 2004 attained to 652 billion Dollars and for G-7 countries (Canada, France, Germany, Italy, Japan, UK and US) it allocated more than 83% of R&D costs in OECD on 2002. Main costs of R&D are expended in USA than other G-7 Countries (OECD science and technology indices, 2007).

By discussing the basic knowledge in economy, policies determined in 20 years perspective note of Islamic Republic of Iran and its five years plans are considerable. Therefore, beginning the knowledge based process begins from R&D and have some percentage role annually in five years economic development plan.

According to following diagram, R&D expenditures in the studied period (2001- 2007) in Iranian Manufacture is ascending. R&D expenditure in manufacture is also increasing during this period.

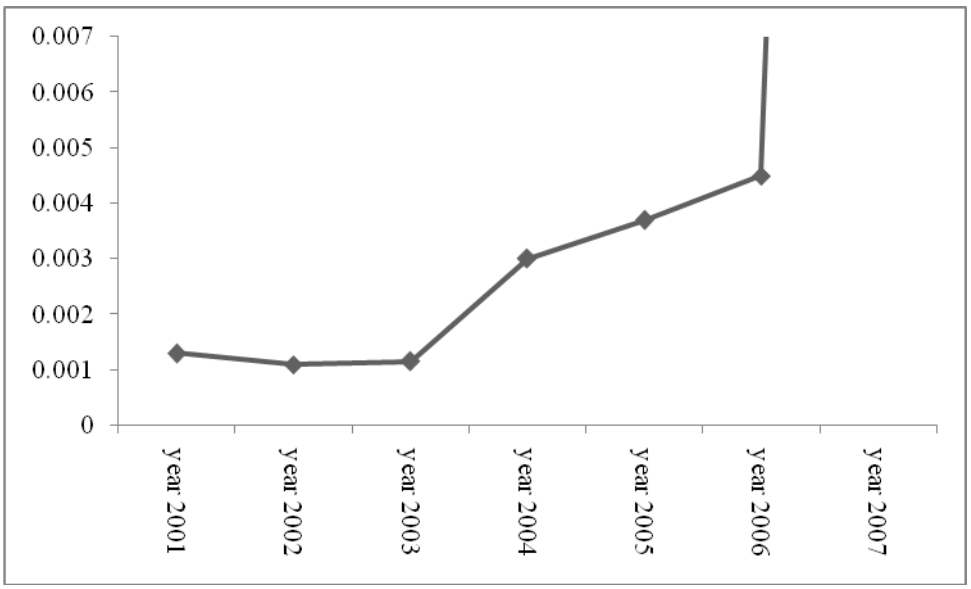

Figure 1. ratio of R&D expenditures than value added in manufacturing sector in Iran

4. Data Definition and Estimation of Model

In order for estimating the model, information related to labor, capital stock, R&D expenditures and value added during 2001- 2007, statistical plans of manufacturing workshops are collected from related tables. During calculations, it is used panel data econometric method, because used data are reviewed in time series and cross sectional.

By Translog Function Form in Barret Verspajen studies, for calculating TFP in this study, Translog production function is given as below:

$$lny = \alpha_0 + \alpha_L lnL + \alpha_K lnK + \alpha_R lnR + \frac{1}{2}\alpha_{LL}(lnL)^2 + \frac{1}{2}\alpha_{KK}(lnK)^2 + \frac{1}{2}\alpha_{RR}(lnR)^2 + \alpha_{LK} lnL\ lnK + \alpha_{LR} lnL\ lnR + \alpha_{KR} lnK\ lnR \quad (4\text{-}1)$$

Cub-Dogloss production function is a specific state of this production function that we studied in this paper. Based on results of coefficients of Translog production function, related tests are conducted such that if simultaneously all production indices α_{ij} are zero and total α_is become a unit, then Translog production function is turned to Cub-Doglos production function.

Continuously, for estimating above mentioned models, initially variables are evaluated based on their stationary and its results indicates stationary of all variables. Then after necessary tests in the panel data method using Eviews Econometrics software, we concluded that model (4-1) has been estimated by fixed effects method. By testing heteroscedasticity, the presence of heteroscedasticity was determined in the model and for removing this issue, it has been used of generalized least square (GLS) method.

Results of model (4-1) using GLS is as below:

$$\ln y = 3.58 + 0.37\ln(L) + 1.52\ln(K) + 0.005 lnR - 0.13\ln(L).\ln(K) - 0.0046\ln(L)\ln(R) - 0.025\ln(K)\ln(R) + 0.22(\ln(L))^2 - 0.067(\ln(k))^2 + 0.009(\ln(R))2$$

Table 1. result of estimating the effect of R&D expenditures on productivity using Tanslog Production Function

Variable	Coefficient	T statistics	Probability level
Ln (L)	0.37	7.88	0.0000
Ln (K)	1.52	16.24	0.0000
Ln (R)	0.005	2.59	0.8800
Ln (L) ln (K)	-0.13	-10.63	0.0000
Ln (L) ln (R)	-0.0046	-0.20	0.8346
Ln (K) ln (R)	-0.025	-2.06	0.0390
Ln (L)^2	0.22	9.08	0.0000
Ln (K)^2	-0.067	-20.09	0.0000
Ln (R)^2	0.009	3.53	0.0004
F= 60.14		R^2= 0.91	
Prob (F)= 0.0000		DW= 2.48	

Results from estimation indicate direct but insignificant relation in probability level 95% between R&D expenditure and productivity. By one unit increase in R&D expenditure in manufacture sector, productivity will be increased about 0.005%. According to coefficients obtained from this estimation $(\alpha_L + \alpha_K + \alpha_R = 1.895)$ the increased returns to scale in this translog production function is determined. Along with reviewing the hypotheses for turning Translog Production Function to Cub-Doglass Production Function by Eviews software, Waled test was conducted and it can indicate that in this study specific state of Cub-Doglass production function may not be applied.

5. Conclusion

This study aims to investigate the effect of R&D expenditure on TFP in Iranian Manufacture sector. According to estimation of model and studied conducted on situation of R&D in Iran and other countries, one can state that no attention and unsuitable investment along with R&D activities in Iran may has low and non-significant effect on productivity in Iranian Manufacture.

According to Translog flexible production function that has increased output in the level of four digits ISIC codes of Iranian Manufacture and given labor, capital stock and R&D expenditures, if there is suitable investment along with R&D activities, one can attain higher production growth and higher productivity level in Iranian Manufacture.

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