

Research Article

Effects of R&D Expenditure on the Profitability of Iran Industrial Firms

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Abstract: This study estimates returns to Research and Development (R&D) Iranian industries. We use a panel data set of Iranian two-digit ISIC manufacturing industries, over the period 2001-2009. The results show that R&D expenditure has a positive and significant effect on profitability. The result shows the great influence of R&D expenditure on profitability of this sector. In other words, these sorts of expenditure have been main effects in increasing the profitability of these industries. We also find that advertisement expenditure and market concentration is an effective factor on profitability.

Keywords: Iranian industries, panel data, profitability, research and development expenditures

INTRODUCTION

Joseph Schumpeter stated in his book, *Capitalism, Socialism and Democracy*, that “the fundamental impulse that sets and keeps the capitalistic engine in motion comes from new consumer goods, new methods of production and new markets” (Schumpeter, 1942). Innovation is the process that manufactures goods and services that are of better quality and lower prices than their predecessors. Therefore, as firms innovate, they inevitably afford about an efficient devotion of the economy’s resources and growth will occur.

The reason for using research and development expenditures as a measure of innovation by a firm is that as firms spend more funds on research and development they are providing their researchers with more resources at their disposal, which should result in a better likelihood of innovating successfully. When firms innovate, they receive patents, which give them a temporary monopoly over the market, which provides excess profits. The excess profits will in turn raise market value (Nord, 2011).

Numerous studies have showed that R&D investments produce positive future operating performance for firms. Lev and Sougiannis (1996) stated that current R&D expenditures were positively associated with subsequent earnings. Eberhart *et al.* (2004) stated that firms that increase their R&D expenditures report significantly positive future operating performance. Past and present empirical research has mainly concentrate don examining whether the stock market recognizes these future benefits correlated with R&D investments. Lev and Sougiannis (1996), Chan *et al.* (2001) and Chambers *et al.* (2002)

found a positive relation between measures of the level of R&D investment and subsequent excess returns.

Amir *et al.* (2004) stated that R&D expenditures were usually expensed because their joint to future benefits was uncertain, whereas capital expenditures were presented in balance sheets due to their ability to produce future cash flows with a high likelihood. Kothari *et al.* (2002) also reported that R&D expenditures have low collateral value and are thus less attractive for capitalization. Low collateral value exists because there are few alternative uses for R&D investments or there is not a substantial liquidation value at the end of the project. Kothari *et al.* (2002) have surveyed how uncertain the economic benefits of R&D investments are compared to other expenditures that firms typically capitalize. They argued that R&D expenditures increase the future earnings variability significantly more than capital expenditures do. For example, future benefits from R&D investments are more uncertain than from capital expenditures. Chambers *et al.* (2000) used price level regressions and have reported the estimated coefficient on capitalized R&D expenditures to be equal with the coefficient on assets, plant and equipment. Amir *et al.* (2004) expanded the survey by Kothari *et al.* (2002) with industry examination and showed that R&D expenditures led to higher volatility of future earnings than capital expenditures only in R&D intensive industries.

As exploring, developing and marketing new ideas often requires significant risk capital, the financial system plays a main role in the cycle of invention, innovation and economic growth. The system’s response, however, largely depends upon how it answers some substantial questions about the value of

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R&D investments. A firm's efforts to increase its technological capital have typically been measured by its R&D spending. And yet equal spending efforts do not related to equal results in terms of profitability and growth.

Also, the returns from R&D spending vary greatly from firm to firm, time to time and project to project. Therefore, in order to recognize the impact of R&D activity, one needs to supplement R&D spending data with information on the quantity and quality of the output from that effort. One may utilize various sources (e.g., patent counts) to assess the importance of R&D output.

As stated previously, this study will evaluate the link between research and development expenditures and profitability. It will do so empirically through regression analysis as well as descriptive statistics. Yearly data will be gathered from the two-digit ISIC Manufacturing Industries of Iran, over the period 2001-2009 and the results are analyzed. The control variables used are market concentration and advertising expenditure. The findings of this study are that research and development expenditures, as well as advertising expenditure and market concentration, have a positive and significant effect on profitability.

MATERIALS AND METHODS

The R&D-earnings relation is estimated from the fundamental relation between assets and the earnings they generate. For accounting purposes, assets generally are categorized as tangible (i.e., assets with physical substance) or intangible (i.e., assets without physical substance). Following Lev and Sougiannis (1996), show the asset-earnings relation as Eq. (1):

$$\text{Earnings}_{it} = g (\text{T Assets}_{it}, \text{I Assets}_{it}) \quad (1)$$

where,

g = The earnings process

T Assets = The tangible assets

I Assets = The intangible assets of firm i in year t

Therefore earnings, tangible asset and certain intangible asset (e.g., purchased goodwill) values are recorded by a firm's accounting system, other intangible assets are not. Accounting regulations require both advertising and Research and Development (R&D) costs to be expensed as incurred. If, however, advertising and R&D expenditures contribute to future earnings, it follows that earnings in any particular year are determined to some extent by both past-year and current-year expenditures. If so, Eq. (1) can be expanded to Eq. (2):

$$\text{Earnings}_{it} = g (\text{ATG assets}_{it}, \text{RD assets}_{it}, \text{AD asset}_{it}) \quad (2)$$

where,

ATG assets = The tangible and intangible assets recorded by firm its accounting system

RD asset = The research and development asset

AD asset = The advertising asset

By definition, the asset value of advertising and R&D expenditures is the contribution of each year's expenditures to future earnings. Lev and Sougiannis (1996) show the R&D asset (RD asset) as:

$$\sum \eta_{i,t-k} * \text{RD}_{i,t-k}$$

where, $\eta_{i,t-k}$ is the contribution of a dollar in R&D expenditure in year $t-k$ ($k = 0, \dots, n$) to earnings in year t . The R&D asset as the sum of yearly asset values and expands the Lev and Sougiannis definition to advertising assets (because of data restrictions, Lev and Sougiannis use current-year advertising expenditures to proxy for advertising assets). The advertising asset is defined as:

$$\sum v_{i,t-k} * \text{AD}_{i,t-k}$$

is the contribution of a dollar in advertising expenditure in year $t-k$ ($k = 0, \dots, n$) to earnings in year t . Substituting the two asset definitions into expression 2 results in Eq. (3):

$$\text{Earnings}_{it} = g (\text{ATG assets}_{it}, \sum \eta_{i,t-k} * \text{RD}_{i,t-k}, \sum v_{i,t-k} * \text{AD}_{i,t-k}) \quad (3)$$

Methods: In this part, the used way is introduced for estimating the model and representing the results and then the findings are subjected to analyze.

Panel data method: In panel data, the similar cross sectional data test during the time. Baltagi (1995) reported that by using panel data, it is possible to determine the effects which can't be determined by cross sectional and time series methods. We can divide panel data in two categories: model with sideways error term and model with bilateral error term. In model with sideways error term, the disturbance term is defined as:

$$u_{it} = \mu_i + v_{it}, i = 1, 2, 3, \dots, N, t = 1, 2, \dots, T$$

That μ_t indicates the unobservable effect and v_i indicates the residual disturbance term. μ_t has time inalterability and considered the personal especial effects which don't enter to regression. The model with bilateral error term is as follow:

$$u_{it} = \mu_i + \gamma_t + v_{it}, i = 1, 2, \dots, N, t = 1, 2, \dots, T$$

μ_i and v_{it} are similar to previous ones in model with sideway error term and in addition, γ_t indicates the time inalterability effect. So the difference between two models is γ_t which has country inalterability and includes the time effect not entering in the regression.

This study highlights the effect of R&D expenditure on profitability of Iranian industries. The estimated econometrics models based on data collected from two-digit Standard Industry Classification during 2001-2009.

We can use both methods or pooling them or using panel data that performs as two forms: fixed effect and random effect, for estimating the model. And by using F-Leamer method can determine which method (pooling method or panel data) must be used for estimating the model. Finally for discrimination between fixed and random effect, it is better to use Hausman test.

Fixed effect method: In the following simple regression, it is assumed that μ_i are the constant parameters for estimation and residual disturbance term (v_{it}) is stochastic, independent and has identical distribution. For all i and t , X_{it} is independent of v_{it} :

$$y_{it} = \alpha + \beta X_{it} + \mu_i + v_{it} \quad (4)$$

By averaging based on time, it can be written as:

$$y_i = \alpha + \beta X_i + \mu_i + v_i \quad (5)$$

And by subtracting Eq. (4) from (5):

$$y_{it} - y_i = \beta(X_{it} - X_i) + (v_{it} - v_i) \quad (6)$$

And by averaging from all observations, we can obtain this estimation:

$$y_i = \alpha + \beta X_i + v_i \quad (7)$$

For getting each μ_i it is used from constraint $\sum_{i=1}^n \mu_i = 0$. This is an arbitrary constraint on the virtual variables coefficients to prevent from falling in the trap of virtual variables or composite correlation. Indeed, only β is obtained from Eq. (6). β held in Eq. (6) and conclude α . By these coefficients and using Eq. (5) each μ_i is earned:

$$\mu_i = y_i - \alpha - \beta X_i \quad (8)$$

F-Leamer's approach: By using Restricted Residual Sum of Squares (RRSS) obtained from estimation the pooling model by OLS and Unrestricted Residual Sum of Squares (URSS) obtained from inter-group regression, we can write:

$$F = \frac{(RRSS-URSS)/(N-1)}{(URSS)/(NT-N-K)} \sim F_{N-1, N(T-1)-K} \quad (9)$$

In F-test, assumption H_0 means being identical the intercepts (pooling method) against assumption H_0 means being no identical the intercepts (panel data method). So, if assumption H_0 would be rejected, the panel data method is accepted.

Random effect: In this condition, it is assumed that μ_i is random $v_{it} \sim \text{IID}(0, \delta_v^2)$, $\mu_i \sim \text{IID}(0, \sigma_\mu^2)$ and μ_i are independent from v_i . In addition, X_{it} for all i and t are independent from μ_i and v_i .

Rencher (2002) with this assumption, it can be written:

$$\mu_{it} = \mu_i - v_{it} \quad (10)$$

$$\text{Var}(\mu_{it}) = \sigma_\mu^2 + \sigma_v^2 \quad (11)$$

So a variance-covariance matrix that indicates the serial correlation during time between disturbance terms of similar countries is made. For estimating the model, it must use Generalized Least Square (GLS) model and consequently variance-covariance matrix Ω is use dIn Fuller and Battes method is used from $[\theta = 1 - (\sigma_v/\sigma_\mu)]$, $\sigma_1^2 = \sigma_\mu^2 + \sigma_v^2$ and the variables are entered as $(y_{it} - \theta y_i)$ in the model and the model is estimated. Of course in random effect, different θ are stated by author's. Therefore $\hat{\delta}_v^2$ and $\hat{\delta}_1^2$ which are the results of inner and outer group estimation, are obtained as:

$$\delta_v^2 = \frac{\sum_{i=1}^N \sum_{t=1}^T (u_{it} - \bar{u}_i)^2}{N(T-1)} \quad (12)$$

$$\delta_1^2 = T \sum_{i=1}^N \frac{\bar{u}_i^2}{N} \quad (13)$$

Hausman test: Hausman test is based on this assumption $H_0 = \text{Cov}(\mu_i, X_{it}) = 0$. In fixed effect method or inner group estimation under assumption H_0 , model is compatible, but no efficient, while under opposite assumption, the model is only compatible. And about the random effect method, the model under assumption H_1 is compatible and efficient, but under opposite assumption is incompatible (Greene, 2000).

Hence, under assumption H_0 , two estimations mustn't have regular difference, now we can test the hypothesis based on this difference as:

$$\text{Var}(\beta - \hat{\beta}) = \text{Var}(\beta) + \text{Var}(\hat{\beta}) - \text{Cov}(\beta - \hat{\beta}) - \text{Cov}(\beta, \hat{\beta}) \quad (14)$$

The essential result of Hausman test is the covariance of efficient estimator with difference of efficient and inefficient estimator is zero:

$$\text{Cov}((b-\hat{\beta}), \hat{\beta}) = \text{Cov}(b-\hat{\beta}) - \text{Var}(\hat{\beta}) = 0 \quad (15)$$

$$\text{Cov}(b, \hat{\beta}) = \text{Var}(\hat{\beta}) \quad (16)$$

By replacing the Eq. (16) in (14), the required matrix of for Hausman test is gotten:

$$\text{Var}(b, \hat{\beta}) = \text{Var}(b) - \text{Var}(\hat{\beta}) \quad (17)$$

In this equation, b is a matrix of estimated coefficients by fixed effect method and $\hat{\beta}$ is a matrix of estimated coefficients by random effect method:

$$W = \chi^2(k) = (b - \hat{\beta}) \Sigma^{-1} (b - \hat{\beta}) \quad (18)$$

Σ is gotten from covariance matrix of estimated coefficients by fixed effects method and covariance matrix of estimated coefficients by random effects. W has distribution χ^2 with freedom degree laterally. If W would be bigger than χ^2 in table, the fixed effect method is accepted.

RESULTS AND DISCUSSION

Model introduction and discussed time period: In this study by reviewing the other used models' Lev and Sougiannis model (1996) is better than the others and specified as following:

$$\text{prof}/s = \beta_0 + \beta_1 \left(\frac{RD}{S}\right)_{it} + \beta_2 CS4_{it} + \beta_3 \left(\frac{AD}{S}\right)_{it} + e_{it}$$

Prof/S is a variable which indicated the profitability that normalized in the regression analysis by dividing by total sales. The normalization creates a control for firm size.

RD as a research and development expenditures and AD/S as advertising expenditure.

In order to control for differences in the size of the firms, however, R&D and advertisement will be normalized by dividing R&D expenditures by sales. AD/S as advertising expenditure and CS_4 is measuring market concentration that in this study is the sum of the market shares of the four largest firms in the market.

So market concentration is the key element in market structure and an important determinant of conduct and performance and hence of the type of

competition and there are many different methods to measure the level of concentrations in different markets. Such as N-Firm Concentration Ratio (CS_n), Herfindahl-Hirschman Index (HHI), Kay-Hannah Index, Entropy Index. This study use the CS_4 that is the percentage of industry Output that is attributable to the four largest firms in that industry and year:

$$CS_4 = \frac{\sum_{i=1}^4 X_i}{X}$$

Our sample and data come from the 2012 Statistics center database. This study highlights the effect of R&D expenditure on profitability of Iranian industries. The estimated econometrics models based on data collected Two-digit Standard Industry Classification during 9 years, presented by a panel data.

I use regression analysis to investigate how R&D, advertising expenditure and market concentration affects the relationship between current R&D investments and the firm's profitability.

Experimental results: In this part, it has estimated the model which determined in previous part and by using EVIEWS software via panel method, fixed and random effect and the effects of independent variables on the firm's profitability are studied.

By comparing measured index F with F index in table, we can say that assumption H_0 isn't accepted with 95% probability because its estimated value is 48.45 so between two methods. Pooling and panel data, it must be selected panel data. Also it has been chosen fixed effect or inner group effect by Hausman test, that comparing with its values in F table, assumption H_0 is not accepted, so based on previous reasons, the analysis must be done by fixed effect.

As finding show, R&D coefficient (7.34) has positive and significant effect on firm's profitability. It indicates that increasing in research and development expenditures in one of the main components for increasing profitability in the industries.

The coefficient of AD expenditures (2.44) is positive and significant, too. This emphasizes results of the other researches. Because as firms spend more on advertising, their product becomes well known and more people should consume it. Patents should have a positive and significant impact on market value as well. As firms obtain more patents relative to other firms, it is a signal of their innovative achievements, indicating the successful means of the company.

Market concentration (CS_4) is one of the other important factors in firm's profitability. Here, this item (0.128) has positive and significant effect (Table 1).

Table 1: Statistical information

Probability	Statistic t	Coefficient	Variable
C	0.174	9.720	0.00
RD/S	7.340	2.195	0.02
AD/S	2.440	2.330	0.00
Cs4	0.128	3.020	0.00
	F-statistic	61.300	
	R-squared	0.900	
	Durbin-Watson stat	1.710	

Finding results

CONCLUSION

In view of managers and experts of firms which have research centers, there is direct relationship between R&D expenditures and increasing share of market, increasing in sale, income and profitability.

According to direct relationship between research costs and profitability of industries which is also compatible with theoretical principles, it can be said that the expenses of research and development can increase future profitability of industries.

Also, encouraging of firms to research and development can lead to improving in quality and innovation of industries besides increasing profitability of industries.

Based upon this fact, justification and informing the managers of firms of effecting role of R&D unites can be useful.

According to the height of the coefficient in R&D expenditure influence to coefficient of advertisements, it can be concluded that in this period, profitability of Iranian industries have received much more influence from research expenditure than two other variables.

So, the conditions require that there is more governmental support of internalizing this important unit in state's industries.

Usage of tax instruments and paying subsidy customs exemption for laboratory equipments and financial support of long-term projects can be solution.

Since the relationship between profitability and concentration ratio in Iranian industries is positive, it can be confessed that efficient firms which have more share of market, also have more profitability due to their structure and expenditure. This is compliant with effectiveness theory too.

This effectiveness in leading firms can be due to proper organizing of resources.

Also, planning for cooperative of working and increasing R&D units in each industry and between

related industries which do complementary activities can decrease the problems and prepare the conditions of increasing researches.

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