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Review

An Investigation into the Relationship between Innovation and Market Structure in Iranian Manufacturing Industries

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The aim of the person study to investigate the relationship between market structure and innovation coefficient in Iranian manufacturing industries. To achieve this objective, Herfindahl-Hirshman Index and Comanor and Willson's scale were considered as measures of market structure. A hybrid fuzzy measure based on such variables as RandD expenditure, the number of experts in each industry and amount of capital equipment import has been used to measure technology coefficient. The present study uses data available from 129 active industries with the four-digit ISIC (international standard industrial classification) from1996 to 2010. The results show that there is an inverted relationship between concentration level and innovation. Moreover, it was found that there is a positive relationship between economies of scale and innovation coefficient in Iran.

Keywords: Herfindahl-Hirshman Index, Economy of scale, Innovation, Hybrid data, manufacturing industries

INTRODUCTION

RandD activities has been the main impetus for innovation in recent decades. In their course of development into a new phase, production-based economies have been replaced by information-based economies. As a result, innovation, research and development have become some of the main contributors to economic growth and development since World War II. Meanwhile, the importance of primary resources and cheap labor has been diminishing, while technological and scientific developments have been gaining in importance. At the same time, the globalization process has affected competition atmosphere, so that firms that posses a monopoly power can affect prices by making new products through novel production methods.

One complicating feature of technological changes is that they results from scientific developments at a very high cost; however, they is transmitted with little cost. Many developing countries try to benefit from the results of RandD activities in advanced countries so that they might avoid high expenditure for innovation. Another complicating feature of technological changes is 'increasing returns to scales'. That is to say, the more globalized economies become, the more important the role production process technology in growth and

competition becomes. As such, technology can be viewed as a type of long term investment, which uses the results of costly innovations to generate new knowledge and produce new products or services in the end.

Experimental research shows that innovation and RandD intensity have a strong positive effect on gross domestic product. High-tech industries account for half of GDP in advanced countries. Thus, the countries that are after innovation and technology at global scale need to link their industrial growth to technology. A famous economist, Robert Solo holds that economic growth and development requires not only capital and work force but also research and development, innovation and novel technologies. However, there is still disagreement as to which market structure is conducive to technological growth. There are two opposite views: On the one hand, Schumpeterian school, otherwise known as the monopoly profit-school holds that monopolistic structure is more helpful to R and D and innovation. On the other hand, The competitive pressure school, otherwise known as Arrow's theory, holds that A competitive structure is beneficial to the afore-mentioned factors.

The present study attempts to answer the following questions:

1. What is the effect of market structure as measured by Herfindal Concentration Index on innovation?
2. Do economies of scale have any effect on innovation level in manufacturing industries in Iran?

The article is organized into four sections. The first section is devoted to introduction. The second section covers theoretical basis for the study and experimental studies. The third section is devoted to methodology of research. The fourth section focuses on the experimental finding and the conclusion of the study.

Literature Review

A review of recent studies reveals disagreements among researchers about the relationship between market structures, innovation, and research and development within different economics schools. Some economists regard market structure as an effective factor on the level of research and development as well as on innovation. Others reject this view. Few studies have been carried out with respect to the role of technology in manufacturing industries in Iran. The following table summarizes such studies.

In studies carried out in other countries, many economists have investigated similar factors, some of which are as follows: Scherer(1967) found an inverted U relationship between innovation level and competition in American markets. Lonn and Martin (1996), following Schumpeter, report that monopolistic markets are more conducive to RandD activities and innovation. They report that an increase in concentration level help to increase innovation level. Axe and Audretchs (1987) findings support Schumpeterian revised hypothesis that has to do with the relative advantage of innovation in small and large firms, though they report that the innovation rate of small firms is higher than that of large firms, the latter group is highly innovative. However, in other industries small firms are innovative. As such, innovation rate is related to the size of the firms, and market structure.

Wagner and colleagues (1992) holds that the relationship between innovation and market structure is not a causal one. Rather, it is a synchronic one.

Den Hertog and colleagues (1993) investigated variables that determine internal and external RandD. The independent variables they studied include the size of the firm, profit making, work force cost to scales ratio. The dependent variable was innovation. Symeonidis (1996) studied the relationship between innovation, market structure and concentration. His findings were in line with Schumpeter's hypothesis. Aghion and colleague (2001) state that when competition increases, innovation increases initially, but after a while, it decreases as the market becomes increasingly competitive.

Gayle (2003) reiterates the Schumpeterian assumption that larger firms spend more on RandD activities and innovation than small firms in order to keep their market power. Such firms are capable of allocating more money to RandD activities than small firms, so he believes that is an inverted U relationship between concentration level, innovation and Research and Development. This hypothesis was supported in experimental studies by Kamien and Schwartz (1982).

Tingvall and Poldahl (2006) estimated the effect of RandD expenditure and innovation, as measure by Herfindal index, on profit making through regression logarithm. They found an inverted U relationship between innovation and Randd expenditure.

Rikard (2006), following Schumpeter, views dynamic efficiency as "creative destruction". This process paves the way for technology and novel organization, which in turn pave the way for new products and processes, and help to improve life standards. Schumpterian theory is often interpreted as positing a positive relationship between RandD, innovation and market power. Proponents of monopolistic profit school believe that having motivation for RandD and innovation help improve social welfare. If a monopolistic business is motivated enough to invest on innovation, then, in a dynamic analysis, monopoly may help increase social welfare. Lobmayr (2010) investigated the relationship between, innovation and concentration with two years observation internal. He found a positive relationship between variables of the study.

The present study is significant in the sense that it can provide new expenditure evidence for the effect of economies of scale (MES) on innovation with a focus on Herfindhal index in large manufacturing industries in Iran.

Table 1. A Summary of Related Studies

Research's name	Results
Khodadad Kashi (2006)	They found that Iranian economy suffers from diseconomies of scale due to its small size. Moreover, there is evidence for incongruity between economics of scale and competition in industrial markets. They also found that the bigger the firm size, the closer the firm is to the optimal production level and the higher return rate.
Fallahi & Dehghani (2010)	They investigated the effect of concentration level and advertising expenditure on profit making in Iranian industries. They found that profit rate is higher in monopolistic and concentrated industries in Iran. Moreover, advertising has a direct effect on profit in Iranian industries.
Fakour & colleagues (2010)	They found that besides informal R&D activities, the most important method of obtaining technology was purchasing machinery and equipment from industrial firms.
Mollaee & Dehghani (2011)	They found a direct and non-linear relationship between R&D expenditure and market share in Iran.
Shahabadi & colleagues (2011)	They state that R&D investment is a major contributor to the advancement of science, increase of productivity, and encouraging growth. They found that intellectual property has positive and significant effect on R&D intensity, but it had statistically no significant effect on economic openness and demand pressure.
Malekan (2011)	He investigated the relationship between profit making as an indicator of performance of economies of scale and concentration ratio as structural elements. He found that in general both economies scale and concentration ratio had a negative significant effect on profit making.
Shahikitash and Nasiriaghdam (2011)	They investigated the relationship among concentration index, cost disadvantage ratio, minimum efficient scale and social cost indices. They found that there is a low degree of competition among firms in water air conditioner industry. Social welfare indices confirmed high social costs due to non-competitiveness of the market.
Sadraeejavaheri and Behzadi (2011)	They investigated the validity of Gibrat hypothesis for small and large firms. They report that results the obtained rejects the validity of this hypothesis among such firms. Instead, they found that small firms enjoyed a higher growth rate than large firms.
Kordbache and Imami(2011)	They investigated the effect of market structure on R&D expenditure in large industries in Iran. They found that in monopolistic industries R&D expenditure is higher than that in other cases.
Mohammadzade and colleagues (2011)	They investigated the probability of R&D activities is positively related to the size of the firm, private ownership, human capital, profit making, and the type of industry. They found that R&D activities is related only to the human capital of the firm.
Khodadadkashi and colleagues (2011)	They investigated the effect of market structure on productivity in Iranian industries. They found that increasing competition has a positive effect on productivity level and a negative effect on productivity growth. They also found that R&D expenditure contributes to productivity.
Asgharpour and colleagues (2011)	They investigated the effect of innovation on instability of market share in food and drink industries. They found a non-linear relationship between innovation and the instability share in food and drink industries in Iran.
Khodadadkashi and colleagues (2011)	They reported that concentration ratio has a significant effect on innovation level, and R&D in manufacturing industries in Iran. They also found an inverted effect between concentration level, innovation and R&D.

Theoretical Framework

Levin and Reiss (1984) modeled Schumpeter theory of monopolistic market. They used a static model for a period in which competition make decisions on their RandD and innovation expenditure level simultaneously. Their model has identical firms that produce homogeneous goods. Profit maximizing condition of a monopoly is equal to one minus price elasticity of demand multiplied by coefficient share market. If each firm has identical market share, profit maximizing condition for each firm would be as follows:

$$\frac{P-C}{P} = \frac{1}{n\,\epsilon_{P,Q}} \quad (1)$$

Now let's take a look at a firm that is a after maximizing profit with three variables, namely, output, technology expenditure, and advertising cost. Thus, the expenditure for this firm is as follows:

$$C_i = c\,(x_i, Z) \quad (2)$$

Let x_i be technology expenditure of the i[th] firm. Let Z be the total technology expenditure of all the firms in the industry including the firm i. In addition, let's suppose that $c_1, c_2 < 0, c_{11}, c_{22} > 0$. This means technology expenditure is decreasing for both the firm in question and the whole industry. In order to determine RandD value, we must first determine the profit equation for each firm, which assuming that unit variable cost is the same and fixed for all firms, and ignoring other costs, is equal to

$$MAX\pi_i = [P(Q,A) - c(x_i, Z)]q_i - x_i - a_i \quad (3)$$

Table1. Estimation Results

Variable	Coefficient	Std. Error	t-Statistisc	Prob
C	1.137238	0.188548	6.031557	0.000
HHI?	-0.068295	0.014762	-4.626502	0.000
MES?	0.140812	0.023482	5.996517	0.000

let π_i be the economic benefit of the i[th] firm , P market price determined by aggregated demand, C unit variable cost, q production of the firm, and R be RandD expenditure. Assuming free entry the formula for all firms in an industry is equal to:

$$[p\,(\,Q\,,A) - \,c(\,x\,,Z)]\,Q = nx + na. \quad (4)$$

By dividing the sides to PQ, the following is derived:

$$\frac{p-c}{p} = R + S \quad (5)$$

The left side is the same as the Learner's Index of Monopoly Power, R is sale ratio of industries sale to RandD expenditure, and S is the ratio of advertising expenditure to sale,

$$\frac{1}{n} = \varepsilon\,(R+S) \quad (6)$$

By comparing equation (1) with equation (6), the following is derived:

$$\frac{nR}{PQ} = \frac{1}{n\,\varepsilon_{P,Q}} \quad (7)$$

The left side of the equation shows the ratio of RandD expenditure to industry sale, which in the literature relevant to industrial organizations is called RandD intensity. On the basis of this equation, the optimal value for RandD intensity for maximizing benefit in the industry is the reverse of price elasticity of demand (PED) multiplied by the number of firms.

In this equation each firm is weighted by a weight equal to its market share, so:

$$L = \frac{P-C}{P} = \frac{1}{\varepsilon} HHI \quad (8)$$

In this equation HHI is Herfindhal – Hirshman Index of Market Concentration. The equation shows the higher the market concentration is, the more the market power of the active firms in the industry gets. By comparing equations (6) and (8), it can observed that RandD expenditure intensity has positive relationship with market concentration and an inverted U relationship with price elasticity of demand. The equation also shows that demand elasticity can be defined as the relationship between concentration index, Randd expenditure of the industry and demand elasticity

$$\varepsilon_{P,Q} = \frac{HHI \times PQ}{nR}$$

Model Explication

This study has used Herfindhal – Hirshman Concentration Index, Komanor and Wilson's Economy of Scale to investigate market structure. Herfindhal – Hirshman Index is one of the most important concentration indices in an industry. Theoretically, it is expected that a positive and non-linear relationship exists between concentration index and RandD expenditure, so that with an increase in market concentration, initially RandD expenditure increases, but after a certain level of concentration has achieved, the reverse happens (Kordbache and Imami, 2011).

The assumption is that minimums efficiency scale is equal to the minimum intake of a production process, in which the average cost in minimal. It can be argued that there is a relationship between the ratio of minimum efficiency scale to sale on the hand and market structure on the other.

The larger the ratio, the larger the share of each firm from demand (in a monopoly structure) and the higher the market power of most firms. For the same reason the ratio of minimum efficiency scale to demand is used as a variable for market structure index, in which case a positive correlation coefficient between innovation cost and this variable confirms the positive effect of a monopolistic market structure on innovation cost. The existence of a negative correlation, however, would mean evidence against this hypothesis.

This study treats innovation proxy as the dependent variable with three components. A fuzzy approach has been employed to integrate three components, namely, RandD, The number of expert workers, and capital goods import to create the innovation proxy. On the basis of theoretical underpinnings of the study, four-digit ISIC codes data for 129 industries between 1996 to 2009 were

used to analyze the relationship between innovation, Herfinhal-Hirshman Index and economies of scale. A regression model was used for the analysis of the data about the relationship between concentration index and economies of scale on one hand, and innovation, on the other hand.

$$innov_{it} = \alpha_i + \beta_1 HHI_{it} + \beta_2 MES_{it} + u_{it} + vi \quad (10)$$

In this equation, $innov_{it}$ is innovation expenditure in the relevant industry code in year t, HHI_{it} is Herfindal-Hirshman Index, MES_{it} is economy of scale, u_{it} is residual component of the model. Data related to industrial units from 1996-2009 with ISIC code were used in order to estimate the equation, F-Limer test was wed to choose between poll or panel mode, to test the model hypothesis since F-Limer statistic was above the critical value at the relevant point, the panel model was chosen to test the hypothesis. Figure 1 depicts model estimation.

The results obtained from estimation model show that both explanatory variables, namely, concentration index and minimum efficiency scale have a positive effect on the dependent variable. One unit increase in Herfindhal index is correlated with 4.626 units.

CONCLUSION

This study used data from 129 firms to test whether concentration index and economies of scale have any effect on innovation. The results support Schumpeter's theory that oligopoly firms are more likely to get involved in innovation and accept RandD expenditure. It was also found that advances in technology can help increase production level, decrease production cost and finally lead to an increase in social welfare.

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