Impact of Structural Components of Market on the Markup Level Based on Radial Basis Neural Network and Fuzzy Logic

Mohammad Nabi Shahiki Tash[*]   Saber Molaei[**]   Kamran Barghandan[***]

Abstract

   This paper aims to evaluate the impact of several indices of market structure including entry to barrier, economies of scale and concentration degree on 140 active industries using the digit. Accordingly, we apply three methods including cost disadvantages ratio (CDR), Herfindahl–Hirschman concentration index (HHI) and Comanor and Willson criterion in order to assess the economies of scale and using the Roger's approach for measuring the Mark up level (μ) in the industries. Hence, in this study first we cluster 140 industries according to the neural network under a radial basis function (RBF) and then identify the mark up level by extracting the rules indicating the relationships of structural variables of the market (i.e. concentration, entry to barrier and economies of scale).

Key Words: Market Structure, Fuzzy Logic, Neural Network, Markup.

JEl Classification: L100, L190, L800.

1. Introduction

   There are some indicators such as economies of scale, concentration and intensity of entry to barrier that can be useful to determine type of a market structure. In other words, based on these criteria we can identify the structure of market and therefore classify that structure. Since this study examines 140 industries with different structures, hence, we first classify the industries with the same properties and then evaluate their structural impact on the markup level. Accordingly, there are also several studies such asAshenfelter (1987); Azzam (1977 and 1990); Azzam et al. (2002); Basu and Fernald (1995); Berndt and Wood (1981); Bersnaban (1982); Bresnahan (1989); Domowilz et al (1988); Ebadi and ShahikiTash

---

[*] Department of Economics, University of Sistan and Baluchestan, Iran. Corresponding Author E-mail: mohammad_tash@eco.usb.ac.ir-

[**] PhD Student in Economics, University of Esfahan, Iran. E-mail:saber.molai@yahoo.com

[***] PhD Student in Economics, Young Researchers and Elite Club,Zahedan Branch, Islamic Azad University, Zahedan, Iran- E-mail: kbarghandan@yahoo.com

(2..4a, 2004b); Hall (1988); Hakura (1998); KhodadadKashi (2000, 2001); KhodadadKashi and ShahikiTash (2005, 2007); Lau (1982); Martin (1988); Perloff (1991); Panzar and Ross (1987); Shapir (1987); Saving (1970); Schroeter (1988) and Diana and Esfahani (2006)that have examined the market structure and power of market in different countries.

The paper employs neural network under a radial basis function for clustering the industries and the fuzzy logic approach to appraise the impact of concentration intensity, intensity of entry to barrier and economies of scale criteria on the level of mark-up index. Accordingly, Table 1 indicates the main goal of the paper intuitively.
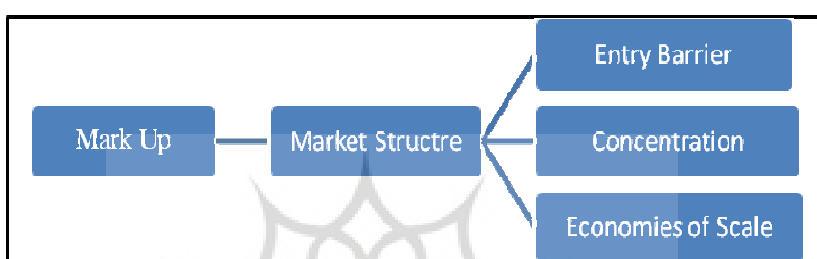

Figure1.Examining the Relationships of Structural Components On Mark UP Level

2. Theoretical Framework

This part of study first explains the theoretical basis of market structural criteria including concentration index, intensity of entry to barrier and economies of scale standards and finally calculates their values for the 140 Iranian industries.

a. Entry to Barrier Intensity

Cost Disadvantage Ratio (CDR) is used to assess the intensity of entry to barrier **as:**

$$CDR = \frac{(n-\nabla)\sum_{i=1}^{\nabla-1}(v_i/l_i)}{(\nabla-1)\sum_{i=\nabla}^{n}(v_i/l_i)}$$

Where the numerator of fraction represents the average value added per person, v_i/l_i, for small firms that generate 50 percent of industry value added. This is while, the denominator is the average value added per person for large firms that have generated 50 percent of industry value

added; Subscribe ∇ is number of firms at the median level. The findings indicate that value of CDR in all 4-digit Iran's industries is less than one. The results obtained from evaluation of this index in Iran industries imply that the larger firm the greater benefits. The CDR size value is between 0.75 and 0.5 for only two industries while the other industries size is less than 0.5 indicating less than 0.1 for 114 industries. Since the closer value to zero show the higher entry to barrier therefore, the most Iranian industries have remarkable barriers (KhodadadKashi, 2005).

b. Market Concentration

The degree of sellers' concentration is recognized as one of the important market structural indicators. It is necessary to determine the number of producers and sellers and type of market distribution in order to evaluate their degree of concentration.

The measure of concentration degree of selling is specified as $C = f(I,n),$ $\dfrac{\partial C}{\partial I} > 0, \dfrac{\partial C}{\partial n} < 0$, where n is number of firms and term I represents how a market is distributed. Based on this criterion, the structure of market is more incomplete and concentrated whatever the number of firms is lower and type of market distribution is more sporadic. The study applies Herfindahl–Hirschman Concentration index as:

$$HHI = \sum_{i=1}^{K} S_i^{2}$$

$$HHI = \sum_{i=1}^{K} S_i^{2} \sum_{i=1}^{K} (x_i (\sum_{i=1}^{K} (x_i)^{-1})^{2}$$

$$S_i = \frac{x_i}{\sum x_i} \qquad i = 1,...,K$$

The index is obtained from sum of squares of market share of all active firms in an industry where S_i is the market share of i-th firm and K is number of active firms. Evaluating the frequency distribution of industries based on H-H index in 2007 demonstrates that 47 percent of the country's industries have $H - H \prec 1000$ with 40 percent of selling while 53 percent of the remaining industries have 60 percent of industry's selling, a concentration value with more than 1000,(KhodadadKashi, 2005).

c. Economies of Scale

There are various methods such as "Profitability Analysis", "statistical methods presented by Florence, Comanor and Wilson ", "Stigler's Survivors technique ", "Delphi technique" and econometric techniques" for evaluating economies of scale and determining optimum size of Manufacturing Enterprise Systems (M.E.S).This paper in order to assess distribution of economies of scale in the Iran's industries has employed the Florence and Comanor technique. The findings demonstrate that the optimum level of production and number of industries with high MES are not large. For instance, just one industry with $MSE_1 = 1$ has been active in the industry's sector. While, only seven industries had a $MES \geq 0.5$. The firms' activities tend to a level that is negligible in comparison with whole market size in most Iranian industrial markets. The size of MES has been obtained less than 0.1 for 127 industries at all 4-digit code. It means that the activity level of a firm is determined in lower level of o.1 in compare with the whole market.

3. Mark-UP

This study to measure the mark up level applies the Roger's approach as bellow:

$$NSRGO_{it} \equiv \Delta(\tilde{p}_{it} + \tilde{q}_{it}) - \tilde{\alpha}\Delta(l_{it} + w_{it})$$

$$-\tilde{\beta}\Delta(m_{it} + p_{it}^m) - (1 - \tilde{\alpha} - \tilde{\beta})\Delta(k_{it} + r_{it})$$

$$= (\mu - 1)\left(\tilde{\alpha}\Delta(l_{it} + w_{it}) + \tilde{\beta}\Delta(m_{it} + p_{it}^m) - (\tilde{\alpha} + \tilde{\beta})\Delta(k_{it} + r_{it}) \right)$$

Where $\tilde{q}$ and $\tilde{p}$ are logarithmic form of production and price respectively, term m indicates intermediate input, term p^m is the intermediate input price, two components $\tilde{\alpha}$ and $\tilde{\beta}$ are share of labour and intermediate input to the gross output value respectively. Moreover, the $NSRGO_{it}$ shows Roger's residual. Thus, the mark-up equation is obtained based on the above equation as:

$$\mu - 1 = \frac{\Delta(\tilde{p}_{it} + \tilde{q}_{it}) - \tilde{\alpha}\Delta(l_{it} + w_{it}) - \tilde{\beta}\Delta(m_{it} + p_{it}^m) - (1 - \tilde{\alpha} - \tilde{\beta})\Delta(k_{it} + r_{it})}{\left(\tilde{\alpha}\Delta(l_{it} + w_{it}) + \tilde{\beta}\Delta(m_{it} + p_{it}^m) - (\tilde{\alpha} + \tilde{\beta})\Delta(k_{it} + r_{it}) \right)}$$

It is noteworthy that this study in order to estimate the Roger's model uses data concerning the industrial enterprises with more than 10 labors over the period 1995-2012 under ISIC codes at the 4 digit level.

4. Clustering the Industries Based on Neural Network under a RBF Function

This kind of network model includes one impute layer and output layer with only one hidden layer as:

$$y_k = e^{-(\frac{\|x - c_k\|^2}{\sigma})}$$

Where $\|.\|$ is a distance under the Euclidean space; subscribe c_k indicates a vector parameter entitled center of neuron; X and σ are an input vector and standard deviation parameter respectively. Least squares approach is a learning algorithm of this model that executed in two stages. At first stage, the centers of intermediate layer of neurons are selected from trained inputs vector which have minimum error. Then, the output layer weights are adjusted to minimize the sum of squared error. Additionally, we can use the type of network for functions approximation and identifying the pattern as well as time series prediction. The structure of this kind of network is displayed as:
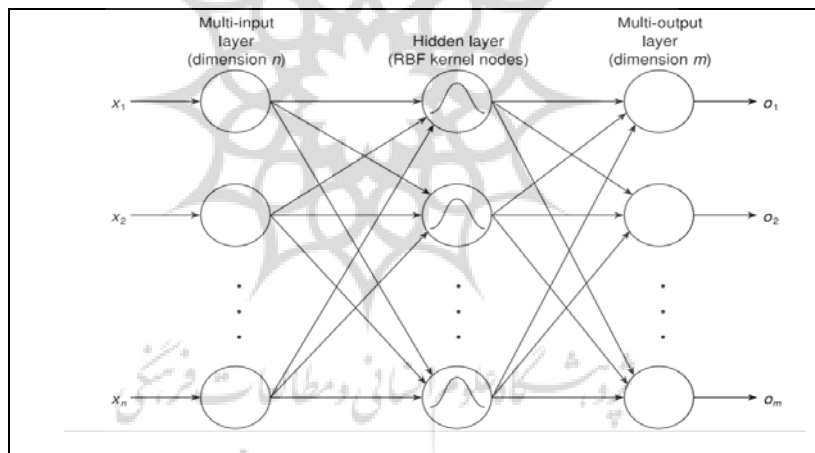
Figure2. Structure of a Network under a Radial Basis Function

This network uses a non-linear transfer function in the intermediate layer. The ordinary transfer functions are Gaussian. A linear transfer function is employed within intermediate and output layers. A logistic function also can be used as a transfer function in this network.

$$y_i = \frac{1}{1 + \exp\left(\left(\frac{\|x - c_k\|^2}{\sigma_i^2}\right)\right)}$$

Every RBF layer comprises of n unites in intermediate and r units in output layer.

$$o_j(x) = \sum_{i=1}^{n} w_{ij} y_i(x) \quad j = 1, \dots, r$$

Where w_{ij} is the correlated weight of i-th input and j-th output. If components G and D are symbol of quantity of transfer function and arbitrary output respectively then the network weights are calculated as follows:

$$D = W * G$$
$$W = G^{-1} * D$$

Occasionally the matrix G is not square, thus using the Pseudo-inverse methods can convert it to an inverse matrix as:

$$G^+ = (G^T * G)^{-1} * G^T$$

So, the network weights calculated as:

$$W = G^+ * D$$

The paper employed a neural network under a radial basis function and 40 neurons in the intermediate layer so that the best value of propagation parameter considered is equal to 0.2.

Table1.A Comparison of error in RBF and OLS Methods

Method	SSR
Ordinary Least Squires	13.2 6
RBF Neural Network	2.65

Source: current Research

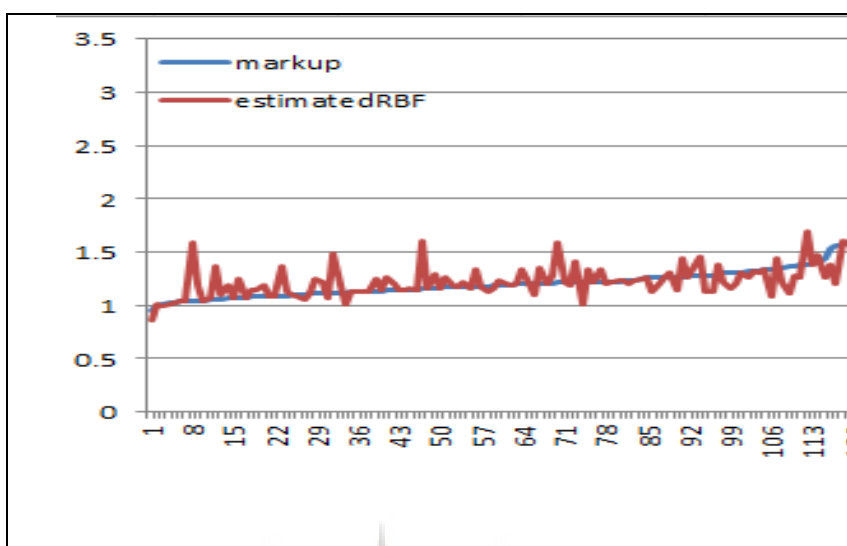The bellow figure also confirms RBF goodness of fit with respect to the actual and estimated values.

Figure 3. Compare of Estimated and Actual values of Markup

5. Analyzing Structure of Market and Markup level Under the Fuzzy Logic

The main objective of fuzzy logic Invention is a description of ambiguous and non-precise phenomenon and forming a math modeling for their utilization and inferences. Linguistic variables are one of the basic concepts in fuzzy logic. For instance, Mark-Up is a linguistic variable that can have low, medium and high quantities. In general, a fuzzy system consists of three components as Fuzzy modeling, fuzzy rules and defuzzyfication stages. In the first stage, inputs are described as linguistic variables and determined their membership functions. the fuzzy rules are selected in the second stage and finally it is employed a method for converting the fuzzy quantities to the Numerical values. Fuzzy inference is the core of fuzzy logic that in fact comprises generating a fuzzy output given the input and fuzzy rules and embodies membership function and "if-then" rules. The three widely used fuzzy inference systems include Mamdani's Fuzzy Model, Takagi-Sugeno's Fuzzy Model and Relational Fuzzy model. There are some approaches like maximum and mean (Centerior fuzzy area) methods for defuzzification of output variable. This paper employed the Mamdani's Fuzzy Model. The study using the input variables including intensity of entry to barrier, economies of scale and

concentration indices attempts to determine the mark-up level as the output variable. 96 observations out of 131 observations related to the markup were classified precisely under the neural network utilization with the RB function.

Additionally, according to the fuzzy approach we examine the impact of the entry to barriers, concentration and efficiency criteria on the Mark up variable and finally we constructed 19 rules for every variable with three low, median and high levels as is shown in the following table:

Table2.The Ranges Determined in the Fuzzy Logic Approach

Variables	Low	Medium	High
Entry Barrier Intensity	[0 0.2]	[0.18 0.5]	[0.4 1.683]
Concentration Intensity	[0 0.12]	[0.1 0.18]	[0.161]
Economies of Scale	[0 0.035]	[0.032 0.15]	[0.13 0.85]
Markup	[0.94 1.4]	[1.2 1.7]	[1.4 3.15]

Source: Current Research

Based on the above ranges, we construct 19 rules concerning the linguistic variables which are represented at table 3. Accordingly, the results estimated based on fuzzy logic approach with Gaussian membership function indicate that where the intensity of entry to barrier, economies of scale and concentration criteria in Iranian industries are at low level therefore the markup level also is low. As well, where the entry to barrier, economies of scale and concentration standards are at low, medium and low levels respectively then the markup level will below. A Gaussian membership function has been selected for every mentioned linguistic variable which are seen in the following figures:
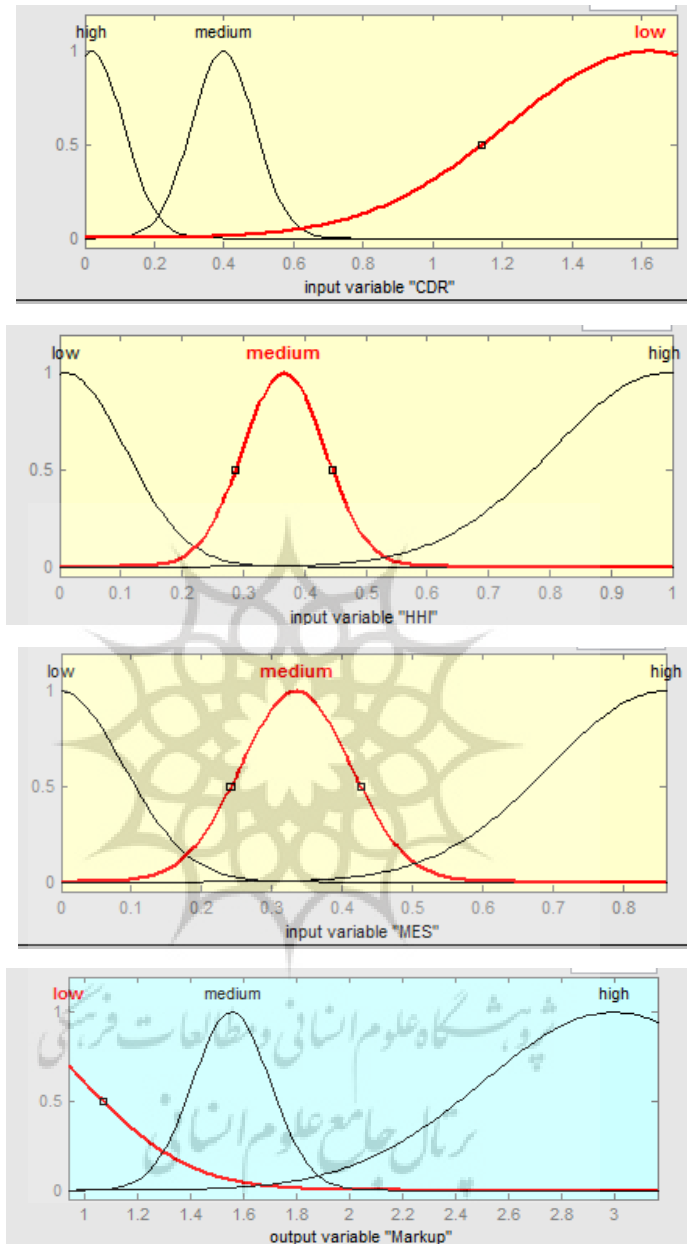
Figure4. Gaussian Membership Function

Table3. The Rules Determined based on fuzzy logic approach for Identifying Market Structure and Markup in the Iranian Industries

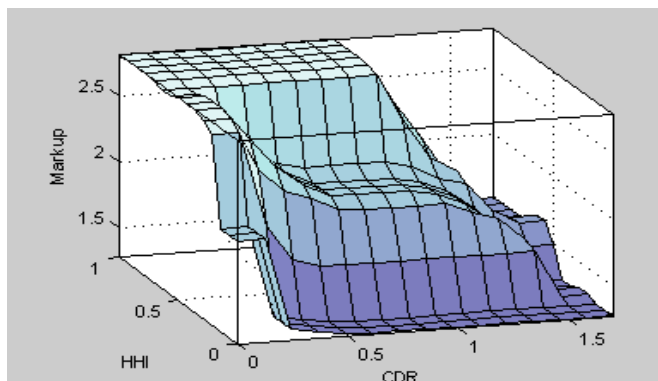| Variables	Entry Barrier	Economies of Scale	Concentration Index	Markup
Rule 1	Low	Low	Low	Low
Rule 2	Low	Low	Medium	Medium
Rule 3	Low	Medium	Low	Low
Rule 4	Low	Medium	Medium	Low
Rule 5	Low	Medium	High	Low
Rule 6	Low	High	High	Low
Rule 7	Medium	Low	Low	Low
Rule 8	Medium	Low	Medium	Medium
Rule 9	Medium	Medium	Low	Low
Rule 10	Medium	Medium	Medium	Medium
Rule 11	Medium	Medium	High	High
Rule 12	Medium	High	Medium	High
Rule 13	Medium	High	High	High
Rule 14	High	Low	Medium	High
Rule 15	High	Low	High	High
Rule 16	High	Medium	Medium	High
Rule 17	High	Medium	High	High
Rule 18	High	High	Medium	High
Rule 19	High	High	High	High

Source: Current Research

The following figures show the relations extracted from fuzzy logic approach:
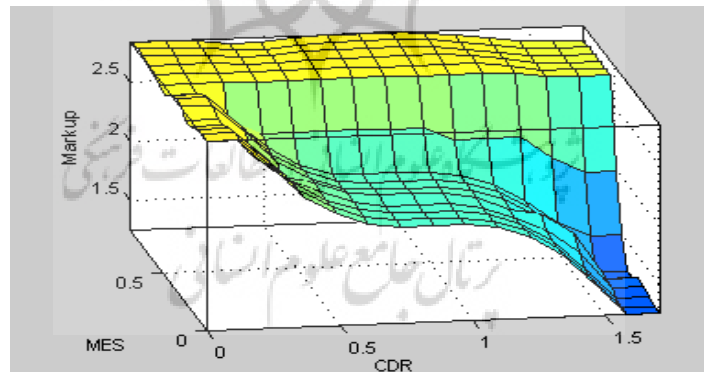
**Figure5.Effectiveness of Entry Barrier And Economies of Scale Variations on Markup**

Source: Current Research

As it can be seen at the above figure, increase in the intensity of entry to barrier and economies of scale criteria lead greater markup.

Figure6. Effectiveness of Entry Barrier And Concentration Intensity Variations on Markup

Source: Current Research
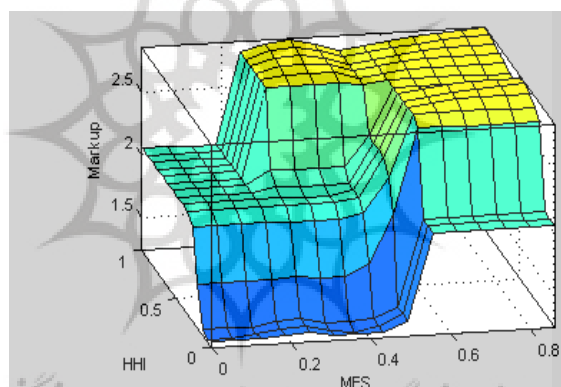
Figure7. Effectiveness of Economies of Scale And Concentration Intensity Variations on Markup

Source: current Research

With respect to the results of fuzzy logic can be concluded that the economies of scale and concentration indices have had a same direction impact on the markup level. It is noteworthy that the clustering results

using RBF neural network in Table 4 shows that dominant behavior of Iran's industries have been based on the following rules:

Table4. Clustering accuracy of RBF Network (Valuesin parentheses are the number in each group)

Variable	Entry Barrier	Efficiency	Concentration Index	Markup	Correctly classified with the RBF
Rule 1	Low	Low	Low	Low(20)	18
Rule 2	Medium	Medium	Medium	Medium(6)	5
Rule 3	Low	Medium	Low	Low(6)	5
Rule 4	Low	Medium	Medium	Low(7)	6
Rule 5	Low	Medium	High	Low(12)	11
Rule 6	Low	High	High	Low(14)	12
Rule 7	Medium	Low	Low	Low(34)	30

Source: Current Research

6. Conclusion

The paper given the neural network under RB function and fuzzy logic attempted to evaluate the impact level of entry to barrier, economies of scale and concentration degree indices on 140 active industries using to theistic codes at the 4 digit. We applied three methods including cost disadvantages ratio (CDR), Herfindahl–Hirschman concentration index (HHI) and Comanor and Willson criterion in order to assess the economies of scale, besides using the Roger's method for measuring the Mark up level (μ) in the industries. The estimated results based on fuzzy logic with Gaussian membership function indicated that where the intensity of entry to barrier, economies of scale and concentration standards in the industries are at low level, therefore the markup level also is low. Additionally, where the entry barrier, economies of scale and concentration are at low, medium and low levels respectively, the markup is also low.

References

1- Ashenfelter O, Sullivan D.(1987),Nonparametric Tests of Market Structure: An Application to the Cigarette Industry. Journal of Industrial Economics;35; 483-98.

2- AzzamA.(1997),Measuring market power and cost- efficiency effects of industrial concentration.Journal of industrial economics;45; 377-86.

3- Azzam A, Pagoulatos E.(1990),Testing oligopolistic and oligopolistic behavior: An application to the U.S. meat packing industry. Journal of Agricultural Economics; 41; 362–370.

4- Azzam A, Lopez R.A, Liron-Espana C.(2002),Market power and/or efficiency: A structural approach. Review of Industrial Organization;20; 115–126.

5- Basu S, Fernald J.G.(1995),Are Apparent Productive Spillovers a Figment of Specification Error?. Journal of Monetary Economics;36; 165-88.

6- Berndt Ernst R, Wood D.O. (1986),U.S. Manufacturing Output and Factor Input Price and Quantity Series, 1908-194 7 and 194 7-1981, Massachusetts Institute of technology, Energy Laboratory; Working Paper 86-01 OWE.

7- Bresnahan T.F.(1982),The Oligopoly Solution Concept is Identified. Economics Letters; 10; 87-92.

8- Bresnahan T.F.(1989),Studies of Industries with Market Power, Handbook of industrial Organization, New York: North Holland.

9- Domowitz I, Hubbard G.R, Petersen B.C. (1988), Market Structure and Cyclical Fluctuations in U. S. Manufacturing. Review of Economics and Statistics;70;55-66.

10- a. Ebadi J, SHahikiTash M.N.(2004),Investigating the Structure of Export Industrial Markets of Selected Goods, Iranian Journal of Trade Studies (IJTS); 31; 33-58. (in Persian).

11- b.Ebadi J, SHahikiTash M.N.(2004),Investigating the Impact of Agricultural Markets Structure on the Iranian Foreign Exchange Earning. Economic Studies of University if Tehran Quarterly;67; 61-90. (in Persian).

12- Hall R.E.(1988),The Relationship between Price and Marginal Cost in U.S. Industry.Journal of Political Economy; 96; 921-47.

13- Hakura D.S.(1998),The Effects of European Economic Integration on the Profitability of Industry.International Monetary Fund; Working Paper WP/98/85.

14- KhodadadKashi F. (2000),Monopoly, Competition and Concentration in the Industrial Markets of Iran. Iranian Journal of Trade Studies (IJTS); 15; 75-96. (in Persian).

15- KhodadadKashi F.(2001), Appraising Power and Volume of Monopoly Activates in the Iran Economy. Institute Trade Studies Researches.(in Persian).

16- KhodadadKashi F, SHahikiTash M.N. (2007), Scope and extent of competition law with respect to the economic structure (Case Study of Iran). journal of Law and economics; 23; 143-179. (in Persian).

17- KhodadadKash F, SHahikiTash M.N.(2005),Degree of Competition in the Global Market OfSelected Agricultural products. Agricultural Economics; 63; 135-164. (in Persian).

18- Lau L.J. (1982),On Identifying the Degree of Competitiveness from Industry Price and Output Data.Economics Letters; 10; 93-9.

19- Martin S.(1988),The Measurement of Profitability and the Diagnosis of Market Power.International Journal of Industrial Organization; 6; 301–321.

20- PerloffJ.M.(1991),Econometric analysis of imperfect competition and implications for trade research. University of California; working paper.

21- Panzar J.C, Rosse J.N.(1987),Testing for "Monopoly" Equilibrium. The Journal of Industrial Economics; 35; 443-56.

22- Shapiro M.(1987),Measuring Market Power in U. S. Industry, National Bureau of Economic Research; Working Paper No. 2212.

23- Saving T.R.(1970),Concentration and the Degree of Monopoly. International Economic Review;11; 139-146.

24- Schroeter J.R.(1988),Estimating the degree of market power in the beef packing industry. Review of Economics and Statistics;70; 158–162.