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Iranian Productivity in Manufacturing Sector: Empirical Evidence Using Panel Estimation Techniques

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ABSTRACT

Rapid changes in demand and supply models, the byproduct of increasing productivity and competition, cause entrants to pay special attention to the conditions of productivity and environment of the competition. Iranian manufacturing sector faces a major problem where its lack of entrants' paying attention to productivity issues. Productivity issues cause a waste of resources and wrong entry decisions. This research employs econometrical models to investigate the determinants of productivity. The three productivity equations are estimated into two categories, that is labour-intensive and capital-intensive sub sectors during the period of 1997-2006. The results indicate that productivity, both in labour, capital and joint labour-capital, in twenty one Iranian industries seem to be highly sensitive to investment sales ratio and minimum efficiency of scale. We review performance indicator roles in manufacturing sector in acquiring results of this study. It increases our knowledge about the Iranian manufacturing structure. The importance of this study stems from a desire to formulate industrial policy based on real empirical knowledge rather than on baseless foundations.

Keywords: Productivity, panel data, pooled OLS, manufacturing sector, labour and capital sub sectors

INTRODUCTION

Productivity and performance are the two most important concepts that have mistakenly been construed as the same in most studies. The producer firm's productivity, an index of performance, can be defined as the ratio of output to input. In fact, the relationship between this two concepts is a single direction: productivity to performance. Productivity depends on other factors. In industrial organization discussions, higher productivity is the synonym of improved competitiveness

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that qualify incumbent firms. Incumbents are competitive when their productivity of labour and capital grow consistently. It allows them to reduce the unit costs of their output and upgrade their profits.

Higher productivity allows funding in an organization's expansion plans. In short term, customers gain from available lower prices in the market. While, in medium term, employees benefit from growth in wages in real terms. The country's living standard increases as the result of productivity growth (Safdari *et al*, 2010; Shepherds, 1990). On the other hand, in macro terms, higher productivity creates the potential for more entry of firms via the increase in investments, exports and demand that includes price reduction, salaries increment and creation of jobs (Fig.1).

Productivity Structure In Iran

The labour productivity in Iran has shown a gradual recovery after the eight-year war with Iraq (1988). Several reasons contributing to the increase of productivity include the high prices of oil, trade and financial liberalization, exchange rate unification and expansionary monetary and fiscal (Jbili *et al.*, 2004).

Iran's economic sanctions, the freezing of foreign assets, volatile international oil market and international economic isolation has caused the country's declining on capital formation. As a result, the country's capital productivity is affected. Furthermore, the population pyramid, based on 1996 census covering 50 percent of below 19 years old, has a significant impact on productivity. To a certain extent, the labour productivity is being attributed by the influx of more than three million refugees from Afghanistan and Iraq (Amuzegar, 2000; Karshenas & Pesaran, 1995).

As part of this changes, Fig.2 and Fig.3 show the estimated labour productivity and capital productivity in the Iranian manufacturing during 1997-2007. Increase

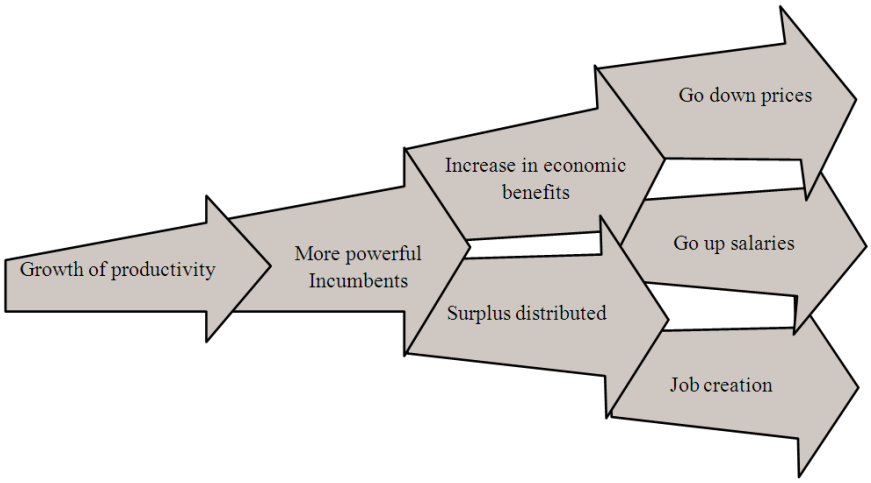

Fig.1: Productivity cycle

in the nominal value added in inflation condition and decreasing growth rate of real wage cause, on average, the labour productivity be somewhat high, while capital productivity is still low. On the other hand, the positive changes are in labour productivity due to rise in the labours' education level. In addition, increasing international sanctions, especially from the USA, in the last three decades causes the scale down of investment in capital. Thus, incapability in renovation of capital decreases capital productivity in manufacturing sector in Iran.

LITERATURE REVIEW

A large number of empirical studies on productivity have been conducted. In many of the studies, the authors use the Total Factor Productivity (TFP) and Cobb-Douglas production function. Many researchers postulate that TFP is a contribution of technological advancement (Kartz, 1969).

Kartz calculates residual factors to show the contribution of technological progress to output and labour productivity growth in Argentina in the period of 1946-1961. He concluded that capital is the major

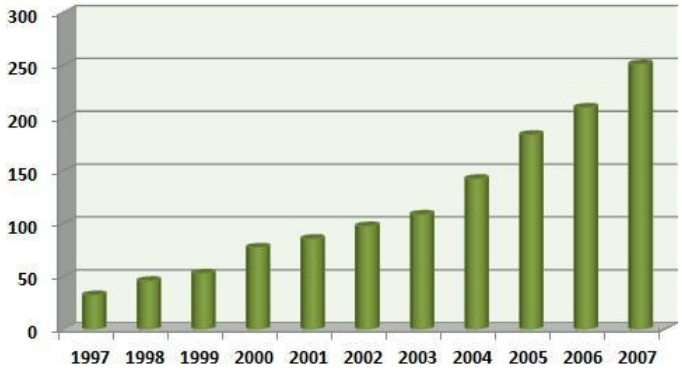

Fig.2: Labour productivity

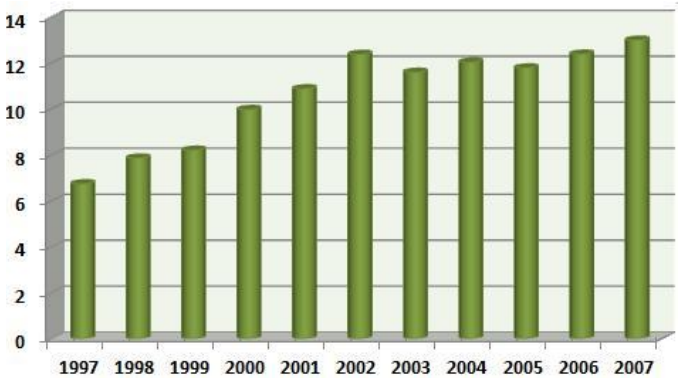

Fig.3: Capital productivity

determinant of labour productivity besides TFP.

Baier *et al*. (2002) examine the relative importance of the growth of physical and human capital and the growth of TFP on 145 countries. They found that TFP growth is an unimportant part of average output growth across all countries. The weighted-average TFP growth is only about 0.13% per year which is about 8% of growth of output per worker. It hardly suggests technological progress. The world average masks interesting variation across countries and regions. TFP growth accounts for about 25% of output growth per worker in Western countries including the United States; 20% in Southern Europe; and 18% in newly industrialized countries.

Mahadevan (2002) uses SFA technique on the South Korean Manufacturing Industry data of 1980-1994 to estimate the TFP growth of four industries, namely food, textile, chemical and fabricated metal. She finds that the output growth of these four industries is increasingly productivity-driven. The export-oriented industry experiences a higher contribution of TFP growth. Furthermore, her study shows that the technical efficiency change is negative in light industries such as food and textile; but was positive in heavy industries such as chemical and fabricated metal.

Huang (2003) studied the growth-output multifactor productivity index using the Törnqvist Index approximation.for the U.S. manufacturing sector. He found that the food manufacturing industry has grown by 0.19% per year between 1975 and 1997. This productivity growth is low compared to the estimation of 1.25% per year for the whole manufacturing sector. Low investment in research and development (R and D) could have been one of the reasons for such low productivity growth. Although productivity has been relatively low, food manufacturing output has grown significantly by 1.88% a year over the 22-year period.

Fu (2005) estimates TFP growth in a panel of Chinese manufacturing industries over the period of 1990-1997. The TFP growth is estimated using the non-parametric methodology, Malmquist Productivity Index which he decomposed it into technological change and technical efficiency change. There is no evidence of significant productivity gains at the industry level resulting from exports in a transition economy. The results suggest that a well-developed domestic market and a neutral, outward-oriented policy are necessary for exports to generate a significant positive effect on TFP growth.

Valadkhani (2005) detected that investments in physical capital and ITT and promoting trade liberalization with the use of Cobb-Douglas production function will improve labour productivity in the long-term. Afrooz *et al.* (2010), in their first study, consider the level of labour, total productivity and technical changes in the Iranian food industry in comparison with total industries over the 1971-2006 periods. They concluded that total factor productivity and labour productivity in food industry, compared to other industries, are lower than average total industries.

In addition, the technical changes is 0.09% in food industry. While, the average for total industries is 0.16% over the period. Afrooz *et al* (2011), as per second study, discuss the effect of human capital on labour productivity in Iranian food industry for the period of 1995-2006. They employed the role of educated workers and skilled workers as a proxy for human capital. The result shows that educated workers and skilled workers have significant and positive effect on labour productivity. In this study, we follow Holtermann's study (1973). Afrooz *et al.* classified labour productivity, capital productivity and expenditure on labour and capital as three productivity indicators that affect industrial performance.

The productivity indicators evaluate different dimensions of productivity. They are not proxies for each other. The performance factors explain inter-industry differences in productivity. Performance variables affect productivity indicators through direct effects on profits. It means that labour productivity, capital productivity and expense on labour and capital change under indirect effects of performance variables. Holtermann (1973), for the first time, uses the market structures in explanation of productivity changes. Unlike other researchers in productivity discussions, his approach is based on Industrial Organization (IO) class.

The key point highlighted in the above mentioned studies is that they focus on macro economics factors of productivity especially TFP and growth. Moreover, the literatures show that most of the researchers are interested in using Cobb-Douglas production function. This study explains the role of micro determinants in three productivity indexes. The authors use the Industrial Organization (IO) approach.

MATERIALS AND METHODS

This study evaluates industry productivity in the Iranian industries using multiple methods of estimation for the years 1997-2006. Changes in the dimensions of productivity indexes vary in different economic structures. Assessing their boundaries requires an understanding of market competition and environmental factors. It necessitates appropriate matching of technology with the industry which can either be labour intensive or capital intensive in order to accurately determine productivity. For example, labour and capital productivity in developed countries which comprise mostly of capital-intensive industries are different from that of developing countries which constitute basically labour-intensive industries. Hence, in order to have an effective determinants of productivity indices, we divide the industries into labour-intensive and capital intensive before running the models. We compare labour cost and capital cost of each industry on annual basis in order to separate the industries into labour-intensive and capital-intensive group. They are selected based on weight of the capital and labour costs. For example, paper industry has been a capital-intensive industry between 1997 until 2002. However, the industry has become a labour-intensive from 2003 until 2006. The details of separation are explained in Table 8.

Here we estimated three models of productivity that contain same explanatory variables put in two categories, that is labour-intensive and capital-intensive industries. Model 1 evaluates the relationship between labor productivity and performance indicators. The former represents the dependent variable and the latter are the independent variables consist of growth rate of demand, capital output ratio, investment sale ratio, advertising intensity and minimum efficiency scale. Model 2 examines the effect of performance indicators on capital productivity. While model 3 estimates overall productivity using the same explanatory variables as that of models 1 and 2.

Examining three alternate dependent variables as three independent models is not only intended to expand the scope of analysis. It is also to provide more comprehensive analysis of industry productivity. Finally, the techniques used to estimate each of the models are pooled cross-section (OLS), fixed effects (LSDV) and random effects (GLS). For each regression model, we test four hypothesis in order to choose the best model (Park, 2009)

Data source

This study uses data from the census of production collected by the annual survey of industries, published by the Statistical Centre of Iran (SCI). This collection covers data of private and public sectors with 10 or more employees. There are twenty one sectors in the two-digit International Standard Industrial Classification (ISIC), as shown in Table 9. Data of a longer period of time is preferred, but it is difficult to collect. Another challenge is that the latest available data dated 2006. Furthermore, several changes have been made on the data processing before 1995-96. Therefore, any data prior to that year are grouped differently and are not classified in the same category as those of 1996 onwards

Functional form of models

The data used in this research is a combination of time series and cross-section which is known as panel data. Panel data approach examines the random and/or fixed effects of groups over time period. The main difference between random and fixed effect models indicates the role of the dummy variables that can help us to control individual heterogenity. It is a random effect model if the dummy variables are considered as an error term. In comparison, the dummy variables play as part of intercept in fixed effect model, (Table 1) (Baltagi, 2008; Gujarati, 2003; Hsiao, 2003, 2005, 2006).

In this study, each specific industry has individual structures that maybe unobservable and unable to measure under particular variables. One of the advantages of panel data is that it allows researchers to control individual structures that each industry employ either fixed or random. The random effects models are considered by generalised least squares (GLS) technique. While, the fixed effects models are estimated by least squares dummy variable (LSDV) technique (Note 1). According to econometric texts (Hasia, 2003; Gujarati,

TABLE 1
Fixed, random and pooled model

	Fixed effect model	Random effect model	Pooled model
Form	$y_{it} = (a+\mu_t) + X'_{it}\beta + \nu_{it}$	$y_{it} = a + X'_{it}\beta + (\mu_t + \nu_{it})$	$y_{it} = a + X'_{it}\beta + \nu_{it}$
Intercepts	Varying across industries and/ or time	Constant	Constant
Error variances	Constant	Varying across industries and/ or time	Constant
Slopes	Constant	Constant	Constant
Estimation	LSDV	GLS	OLS

2003; Baltagi, 2008), the choice between a fixed and random model depends on the nature of the data. In this paper, we use both LSDV and GLS in order to facilitate the comparison with previous research results. The OLS result is also shown here. Many studies are only based on OLS estimation.

The empirical models used in the study is as shown below. Model 1 evaluates labor productivity. Model 2 examines the effect of performance indicators on capital productivity, while model 3 estimates the overall productivity.

$$\mathrm{LP}_{it} = \alpha_0 + \alpha_1 MES + \alpha_2 GR + \alpha_3 IS + \alpha_4 AD + \alpha_5 KI + \theta_{it} + \varepsilon_{it} \quad (1)$$

$$\mathrm{CP}_{it} = \alpha_0 + \alpha_1 MES + \alpha_2 GR + \alpha_3 IS + \alpha_4 AD + \alpha_5 KI + \theta_{it} + \varepsilon_{it} \quad (2)$$

$$\mathrm{LCP}_{it} = \alpha_0 + \alpha_1 MES + \alpha_2 GR + \alpha_3 IS + \alpha_4 AD + \alpha_5 KI + \theta_{it} + \varepsilon_{it} \quad (3)$$

Where:

LP = Labor productivity
CP = Capital productivity
LCP = Overall productivity (total expenditure productivity)
MES = Minimum efficiency scale
GR = Growth rate of demand
IS = Investment-sales ratio
AD = Advertising intensity
KI = Capital-output ratio
θ_{it} = The unobservable market factors and ε_{it} is the error term; Both of them are independently and identically distributed

Dependent variables

Labour Productivity (LP) or net output per person employs estimations of value added to the used materials (labours) in the production process.

Capital Productivity (CP) or net output per unit of capital calculates the value added of used capital in the production process as:

$$\mathrm{LP}_{it} = {\mathrm{VA}_{it}}/{\mathrm{L}_{it}} \text{ and } \mathrm{CP}_{it} = {\mathrm{VA}_{it}}/{\mathrm{C}_{it}}$$

where, VA denotes nominal value added, L labour input and C capital input for industry *i* at time *t*. Total expenditure on both capital and labour (LCP) or value added per $1000 expenditure on capital and labour are instead of evaluating the productivity of each unit separately. Total factor index is a measurement of value added over total expense as:

$$\mathrm{LCP}_{it} = {\mathrm{VA}_{it}}/{(\mathrm{Kr}_{it} + \mathrm{Lw}_{it})}$$

where, *r* is the opportunity cost of capital (interest rate) and w is the average wage rate. The availability of data to clarify opportunity cost of capital (interest rate) is not clear. Therefore, we use expected rates of return on facilities in manufacturing sector as explained by Central Bank of Iran (CBI) (Note 2).

INDEPENDENT VARIABLES

Minimum Efficiency Scale (MES)

One of the objectives of this study is to test the simple hypothesis where there is a negative relationship between MES as entry barrier and productivity indicators. As we have known, expected profit rate of an entrant depends on changes in productivity such as labor and capital productivity. On the other hand, a decline in entry barriers increases expected profit of entrants. Therefore, we can conclude that a reduction in barriers to entry raises profits leads to improvement in productivity. We can employ the ratio of the average size of the largest incumbents which account for 50% of the industry's employment (output) over total employment (output) in determining efficient size. Here we are faced with two choices in estimating the minimum efficiency scale. It is either we use the employment base or output base. In view of inflation, we prefer using the employment base in measuring MES. We assume that the MES is a barrier to entry and has a negative relationship with productivity indicators (Holtermann, 1973; Schmalensee, 1981).

Advertising Intensity (AD)

Advertising expenditure may create an additional entry barrier if it increases the incumbents' profits. Advertising affects on profit can be seen via two modes. Firstly, expenditure on advertising may establish a barrier for new entrants; thus, incumbents will continue enjoying more profits. Secondly, incumbent firms will expand advertising expenditure in order to increase their market shares through shifts in the demand curve.

We can expect advertising to have a positive effect on the productivity indicators through positive changes in profits, or alternatively having a negative effect as it poses a barrier to entry (McAfee *et al*., 2004). We compute the effects of advertising by advertising intensity as follows:

Advertising Intensity (AD) = Expenditure on Advertising /sales.

Growth Rate of demand (GR)

The MES and AD explain variations in profit. However, other market performances like GR have positive impact on profits. It is easier to make profits in a growing market than a stagnant market. Growth of demand or a moving demand curve to the right causes higher equilibrium price that leads to increases in profits.

It is necessary to increase supply to meet the growing demand which will be covered through expansion of capacity of incumbents firms or entry of new firms. In the absence of the supply, higher profits are made by incumbents firms (Holtermann,

1973). We expect GR to explain changes in productivity indicators that include labour productivity, capital productivity and overall productivity, through increase in profit. We measure GR by the annual changes in sales value as proxy for demand growth between 1996 and 2006.

Capital-output ratio (KI)

The KI is an efficiency measure for firms. It shows how much is invested to gain one unit of output or sales revenue. Each industry employs specific technology which is reflected in different ratios of capital to labour. Industries with low capital-output ratio or with less use of capital compared to labour, are expected to have higher rates of return on capital. These industries are also expected to have lower rates of return on labour and vice versa (Holtermann 1973). Optimization in capital tools causes labour to be more effective. In addition, growing capital directs labour productivity. Overall, capital intensive industries are apt to have higher standards in the long run. We estimate KI as ratio of capital value to output over a specified period of time. It is hypothesized that KI has positive effects on labour productivity and negative effects on capital productivity. Morever, they may cancel each other's effects on overall productivity (Holtermann, 1973).

Investment-Sale ratio (IS)

Investment guarantees growth of production capacity and renovation of old capital. In both cases, we can expect new investment to push up use of new technologies. Therefore, use of new technologies raises profit through lowering costs (Holtermann, 1973). On the other hand, investment in human capital means an increase in labour. It may cause a decline in labour productivity. While, investment in capital means an increase in the number of machinery and equipment. Similarly, it may cause a decline in capital productivity. Hence, growth of investment has an ambiguous effect on productivity indicators. Moreover, we can expect the existence of negative correlation between investment and labour productivity and between investment and capital productivity.

Investment sales ratio is calculated as ratio of investment value to sales over a specified period of time (Holtermann, 1973). Investment value consists of investment on machineries, durable goods, office instruments, transport vehicles, buildings, lands and computer software.

RESULTS

Regression results for LP

Table 2 and 3 show the results for labour productivity in both labour-intensive and capital intensive groups. In models 1.1 (1.1 for labour-intensive group and 1.1 for capital-intensive group), we employ a pooled method by controlling labour productivity through 1997-2006 period. As a result, we find significant relationships exist between the dependent variable and investment sales ratio, minimum efficiency scale and advertising intensity in the labour-intensive group. However, only minimum efficiency of scale is significant in the capital-intensive group.

TABLE 2
Results for industry labour productivity (labour-intensive group), 1997-2006

Variable	Model 2.1 OLS	Model 2.2 LSD (2-way)1)	Model 2.3 GLS
KI	-238.4**	40.23	-187.6**
IS	-449.4**	-226.7**	-400.4**
GR	16.47	22.32	-0.082
MES	-558**	-52.63	-35.4*
AD	2307*	216.4	2357*
R-squared	0.143	0.918	0.164
Time effect test	F (9, 11) =30.42	Prob>F = 0.945	
Wald test	F (29,111) = 36.55	Prob>F = 0.000	
LM test	chi 2(1) = 49.40	Prob>chi2 = 0.052	
Hausm an test	chi2 (5) = 2.14	Prob>chi2 = 0.464	

TABLE 3
Results for industry labour productivity (labour-intensive group), 1997-2006

Variable	Model 2.1 OLS	Model 2.2 LSD (2-way)1)	Model 2.3 GLS
KI	-384.2***	-240.**	-329
IS	103.5	4.76	-53.73
GR	6.32	6.70	-3.66
MES	-870*	-2801	193.9
AD	-3969	-3056	-27154***
R-squared	0.455	0.884	0.397
Time effect test	F (9, 11) = 2.32	Prob>F = 0.0386	
Wald test	F (29,111) = 4.59	Prob>F = 0.000	
LM test	chi 2(1) = 22.28	Prob>chi2 = 0.000	
Hausman test	chi2 (5) = 11.44	Prob>chi2 = 0.043	

The differences in significance of variables in both labour-intensive group and capital-intensive group are due to size of independent variables. It means that the size of advertising costs and capital costs in labour- intensive group is a noticeable value in comparison with capital-intensive group.

Nevertheless, the result of capital output ratio is statistically accepted even though it is not consistent with the theory that capital output ratio has positive effect on labour productivity.

In order to account for the possible existence of unobservable heterogeneity across industries, we estimate model 1.2 (1.2 for labour-intensive group and 1.2 for capital-intensive group) with a LSDV fixed effects model. As a result, we find that there is a significant relationship between dependent variable and investment sales ratio and growth rate in labour-intensive group. However, there is no statistical significant relationship between the independent variable and dependent variables in capital-intensive group.

Finally, models 1.3 (1.3 for labour-intensive group and 1.3 for capital-intensive group) estimate the random effects models as an alternative estimation. The result of these models indicate that the investment sales ratio, minimum efficiency of scale and advertising intensity have statistical significant effect on labour productivity in labour-intensive group. Meanwhile, only advertising intensity has significant effect in capital-intensive group.

The terms of panel and pool data are often used. In this study, the nature of the data for the 21 industries which is a as cross-section data, repeated between 1996-2006. This justificies that the panel model is appropriate. However, we need statistical justification to demonstrate the validity of the model. Greene (2003; Wooldridge, 2006; Park, 2009) have considered some statistical justification tests (Table 10). These tests are Group specific test for time-fixed effects, Breusch and Pagan LM test and Hausman test.

We use F test to consider the necessity of time effect in the first test. The null hypothesis is that the effects of time are zero. In this case, F values for both labor-intensive and capital-intensive groups are significant. We can reject the null hypothesis that is all years' coefficients are jointly equal to zero; therefore, time fixed effects are needed. The second test indicates whether the pooled or fixed-effects model (LSDV) is more appropriate. The test rejects the null hypothesis.

Evidently, we can conclude that two-way LSVD model is better than the pooled OLS model. In the third test, the LM test helps to decide between a random effect model and an OLS model (pooled). The evidence indicates a random effect model. Finally, the Hausman test directs random effect model to the labor-intensive group. However, this test cannot choose random effect model for the capital-intensive group. Henceforth, the random model is preferred to the labour-intensive group and the fixed effect model is preferred to the capital-intensive group.

Regression results for CP

Table 4 and 5 display the results of capital productivity models in two categories. The results indicate that the relationship between investment sales ratio and capital productivity in both categories and all three models (2.1, 2.2 and 2.3) are negative and statistically significant. These results indicate wrong investment or wrong entry into Iranian industries causing a waste of resources. The evidence of wrong investment can be seen in number of entries and exits into the industries (Fig.4). Investors in Iranian manufacturing sector merely use the financial facilities such as loans and subsidie from governmental resources to enter into inappropriate industries. Subsequently, arbitrage opportunities of government's loans in informal markets drive loans to other sectors.

According to statistical justification tests, the random effect model is preferred for both labour-intensive and capital-intensive groups.

Regression results for LCP

Table 6 and 7 show the result of regression on overall productivity in both labour-intensive and capital- intensive groups. In the labor-intensive group, the investment sales ratio, growth rate, advertising intensity and minimum efficiency scale as explanatory variables in LSDV and GLS models have significant effects. The investment sales ratio, growth rate, advertising intensity and minimum efficiency scale have significant effects in the labor-intensive group, similar

TABLE 4
Results for industry capital productivity (labour-intensive group), 1997-2006

Variable	Model 2.1 OLS	Model 2.2 LSD (2-way)1)	Model 2.3 GLS
KI	4.81	-0.926	1.80
IS	-211.5***	-228.6***	-224.2***
GR	-2.78	-1.46	-1.80
MES	17.5	-32.11	-11.71
AD	206.7	179.4	208.9
R-squared	0.437	0.597	0.487
Time effect test	F (9, 11) = 0.37	Prob>F = 0.0945	
Wald test	F (29,111) =12.06	Prob>F = 0.000	
LM test	chi 2(1) = 3.76	Prob>chi2 = 0.052	
Hausman test	chi2 (5) = 4.62	Prob>chi2 = 0.464	

TABLE 5
Results for industry capital productivity (capital-intensive group), 1997-2006

Variable	Model 2.1 OLS	Model 2.2 LSD (2-way)	Model 2.3 GLS
KI	-11.36	-14.31	-11.79
IS	-33.22***	-38.82***	-37.75***
GR	1.48	2.01	1.4
MES	-11.86	-78.22	-2.6
AD	10.35	-155.4	-79.81
R-squared	0.411	0.735	0.492
time effect test	F(9, 32) = 0.99	Prob>F = 0.467	
Wald test	F(9, 32) = 3.48	Prob>F = 0.000	
LM test	chi2 (1) =10.77	Prob>chi2 = 0.001	
Hausman test	chi2 (5) =1.31	Prob>chi2 = 0.933	

TABLE 6
Results for Industry Overall Productivity (labour-intensive group), 1997-2006

Variable	Model 2.1 OLS	Model 2.2 LSD (2-way)	Model 2.3 GLS
KI	-1.75	2.49	2.34
IS	-27.29	-10.20***	-11.55**
GR	2.11***	1.14***	1.17****
MES	-7.87	-17.36***	-16.84***
AD	57.74	-73.46**	-71.56**
R-squared	0.152	0.863	0.230
Time effect test	F (9,111) = 1.28	Prob>F = 0.256	
Wald test	F (20,120) = 31.39	Prob>F = 0.000	
LM test	chi 2(1) = 82.85	Prob>chi2 = 0.000	
Hausman test	chi2 (5) = 5.46	Prob>chi2 = 0.362	

TABLE 7
Results for industry overal productivity (capital-intensive group), 1997-2006

Variable	Model 2.1 OLS	Model 2.2 LSD (2-way)	Model 2.3 GLS
KI	-1.23	1.68	1.05
IS	-19.09**	-22.71***	-22.40***
GR	3.57**	2.81**	2.81****
MES	-68.10	-94.06	-55.30
AD	-335.9*	-196.9	-233.7
R-squared	0.427	0.862	0.4522
Time effect test	F (9, 32) = 1.28	Prob>F = 0.581	
Wald test	F (17, 41) = 31.39	Prob>F = 0.000	
LM test	chi 2(1) = 82.85	Prob>chi2 = 0.000	
Hausman test	chi2 (5) = 5.46	Prob>chi2 = 0.984	

Note: for OLS and LSDV t-statistics in parentheses and for GLS z-statistic in parentheses;
*; significant at 10%; **; significant at 5%; ***; significant1%

to the explanatory variables in LSDV and GLS models. However, only growth rate has significant effect in the pooled OLS model.

In capital-intensive group, the investment sales ratio and growth rate are significant in all three models. In addition, advertising intensity and minimum efficiency scale have significant effects in pooled OLS model. The statistical justification tests indicate the random effect model is appropriate for third models.

DISCUSSION

Productivity and performance are the two most important concepts that have mistakenly been construed as the same in most studies. The productivity of a producer

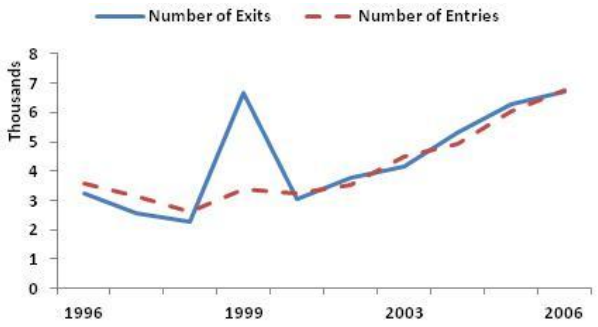

Fig. 4: Number of entry and exit in Iran manufacturing

Table 8
Labour-intensive and capital-intensive separation

Year ISIC code	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
15	Capital	Capital	Capital	Capital	Labour	Labour	Capital	Labour	Capital	Labour
17	Labour	Labour	Labour	Labour	Labour	Labour	Labour	Labour	Labour	Labour
18	Labour	Labour	Labour	Labour	Labour	Labour	Labour	Labour	Labour	Labour
19	Labour	Labour	Labour	Labour	Labour	Labour	Labour	Labour	Labour	Labour
20	Labour	Labour	Labour	Labour	Labour	Labour	Labour	Labour	Labour	Labour
21	Capital	Capital	Capital	Capital	Capital	Capital	Labour	Labour	Labour	Labour
22	Capital	Capital	Labour	Capital	Labour	Labour	Labour	Labour	Labour	Labour
23	Capital	Capital	Labour	Labour	Capital	Labour	Capital	Labour	Labour	Labour
24	Capital	Capital	Capital	Capital	Capital	Labour	Labour	Capital	Capital	Labour
25	Capital	Capital	Capital	Capital	Labour	Capital	Labour	Labour	Labour	Labour
26	Capital	Labour	Capital	Capital	Capital	Labour	Labour	Labour	Labour	Labour
27	Capital	Capital	Capital	Capital	Capital	Capital	Capital	Capital	Capital	Capital
28	Labour	Labour	Labour	Labour	Labour	Labour	Labour	Labour	Labour	Labour
29	Labour	Labour	Labour	Labour	Labour	Labour	Labour	Labour	Labour	Labour
30	Labour	Labour	Labour	Labour	Labour	Labour	Labour	Labour	Labour	Labour
31	Labour	Labour	Labour	Labour	Labour	Labour	Labour	Labour	Labour	Labour
32	Labour	Capital	Capital	Labour	Labour	Labour	Labour	Labour	Labour	Labour
33	Capital	Capital	Labour	Labour	Labour	Labour	Labour	Labour	Labour	Labour
34	Capital	Capital	Capital	Capital	Capital	Capital	Capital	Capital	Capital	Capital
35	Labour	Labour	Labour	Labour	Labour	Labour	Labour	Labour	Capital	Capital
36	Labour	Labour	Labour	Labour	Labour	Labour	Labour	Labour	Labour	Labour

* Capital means capital-intensive and Labour means labour-intensive
* An industry is considered as labour or capital intensive based on comparison between required labour cost and capital cost. The author compares the labour cost and capital cost of each industry in every year. E.g. if the labour cost is more than capital cost the industry is specified as labour intensive industry.

TABLE 9
Manufacturing sectors in Iran based on the 2-digit ISIC Code

Industry	SIC code	Industry	SIC code
Food products and beverage	15	Wearing apparel	18
Textiles	17	Wood products and cork	20
Tanning and dressing of leather; luggage,…	19	Publishing, printing and	22
Paper products	21	Chemicals and chemicals products	24
Coke, refined petroleum	23	Other non- metallic mineral	26
Rubber and plastic product	25	Fabricated metal pro, except machinery	28
Basic metal	27	Office, accounting and computing	30
Machinery and equipment NEC	29	Radio, TV and communication equipment	32
Electrical machinery and apparatus NEC	31	Motor vehicles, trailers and semi trailer	34
Medical, precision and optical instrument	33	Furniture; manufacturing NEC	36
Other transport equipment	35		

Source: Statistical centre of IRAN (ISIC is abbreviation for International Standard Industry Classification)

TABLE 10
Summary of statistical test

Test	Time-fixed	Wald	LM	Hausman
Labour productivity				
Labour-intensive	2-way	LSDV (2-way)	Random	Random
Capital-intensive	2-way	LSDV (2-way)	Random	Fixed
Capital productivity				
Labour-intensive	1-way	LSDV (1-way)	Random	Random
Capital-intensive	1-way	LSDV (1-way)	Random	Random
Overall productivity				
Labour-intensive	1-way	LSDV (1-way)	Random	Random
Capital-intensive	1-way	LSDV (1-way)	Random	Random

*; Summary of statistical test that is used in this study as statistical justification to choose appropriate model

firm can be defined as the ratio of output to input. It is an index of performance. In fact, the relationship between both concepts is a single direction: productivity to performance. Productivity depends on other factors. In industrial organization (IO) discussion, higher productivity is the synonym of improved competitiveness that qualifies incumbent firms. Incumbents are competitive when their productivity of labor and capital grow consistently. Such situation allows them to reduce the unit costs of their output and upgrade their profits that causes entry to raise.

Matching of technologies with industries and being either capital-intensive or labor-intensive plays an important role in the structure of industries. For example, the labor and capital productivity are different in developed countries from developing countries. The former are almost capital-intensive, while the latter are almost labor-intensive. Increase in productivity leads to improvement of the Iranian manufacturing structure.

CONCLUSION

The objective of this study is to analyse the relationship between productivity measures and performance indicators (capital output ratio, investment sales ratio, advertising intensity, growth of demand and MES). This paper illustrates in detailed the general picture of the productivity patterns in the

Iranian manufacturing sector. A unique firm-level data supports the main part of the industry sector of Iran during the period of 1997-2006 that are used in the empirical analysis. The results indicate that productivity indices seem to be highly sensitive to the investment sales ratio. Increasing investment in labour and capital do not follow growth in productivity. Therefore, wrong investments or wrong entries take place in Iranian manufacturing sector. The evidence of wrong investment is seen in a number of entries and exits into the industries. This indicates that there is lack of stable financial rules in the government sector.

The performance indicators used in this research are based on previous empirical finding (e.g. Holtermann 1973). Besides, the research makes an empirical and methodological contribution by employing panel data methods applied to the unique dataset.

POLICY IMPLICATION

The results of this paper have implications to policy makers. The policy makers intend to guide owners of industrial firms in expanding their businesses. Knowledge of the variables that influence the productivity measures is valuable to policy makers in planning growth strategies for the manufacturing sector in Iran. The significance of the mentioned variables indicates that investors and incumbents must pay attention to optimizing the use of capital tools. It is due to the evidence that growing capital intensifies direct labour productivity. Furthermore, the significance of MES in labour-intensive groups of models of 1 and 3 states that the MES as entry barrier causes increases in profit. Hence, improvements in productivity.

Note 1: There are two kinds of fixed model. It is called one way fixed model if the unobservable variables are dependent only on the cross-section to which the observation belongs. It is called two-way fixed effect model when panel approach allows the unobservable variables vary across both cross sections and time period.

Note 2: Money and Credit Council determines the regulations pertaining to determining lending rates or the expected rate of return on the banking facilities, and the provisional deposit rates as a result of law implementation on usury free banking and introduction of contracts with fixed return and transaction contracts. The expected lending rates are related to the facilities extended by public banks.

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