Determinants of Labor Productivity in Manufacturing Firms of Iran:Emphasizing on Labor Education and Training

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Abstract

In an era of globalized competition, productivity has become a crucial factor determining profitability, competitiveness and the growth of a firm. High productivity means lower per unit cost and, therefore, ability of the firm to match prices on the global markets. Because of that, there has been an increasing interest recently in the literature on factors affecting productivity. This paper investigates the determinants of labor productivity at the firm level in the Iran's manufacturing sector. The analysis is based on descriptive statistics and cross sectional regression models on a sample of 12299 Industrial firms. The results show that labor productivity is positively related to wage, fixed capital per employee, export orientation, R&D activity and Education of labor force.

Key Words: Labor productivity, Industrial firms, Education, Training, Export, R&D

JEL Classification: J24, L60, D23.

1-Introduction

With increasing globalization and the expansion of competition in industrial products market, labor productivity more than before has become determining factor in the competitiveness of industrial products and thus profitability of industries in domestic and foreign markets. High labor productivity means lower per unit cost and, therefore, ability of the firm to match prices on the global markets. Because of that, there has been an increasing interest recently in the literature on factors affecting labor productivity and productivity growth.

Although, the results of studies at the firm level indicates that factors such as R&D expenditure of firm, the level of information technology in the Firm (IT), export intensity of firm, the size of firm and several other factors is known most important factors which affecting the productivity of labor in a firm, but the training of human resources and education has a special place over the above mentioned factors and more than other factors have been emphasized by researchers. Workforce education and training level that the firm will be given to labor usually is recognized as human capital in the economic literature. Accumulation of these capitals generally by increasing skills of labor force led to increasing efficiency in utilization of physical capital as well as led to facilitating the process of obtaining or creating and using new technologies in the production process and finally increases labor productivity and profitability in the enterprise.

In Iran, the necessity to promote industrial competitiveness, require more attention to labor productivity and its determinants, but there is no study that is addressed this issue. The purpose of this study is investigation of factors affecting labor productivity among industrial firms in 2007 with an emphasis on education and training levels provided by the enterprise to the employees. For this purpose, using statistical data from census plan of industrial firms with 10 employees and more[1], includes 12,299 active firms and estimation of a cross-sectional regression, we analyze the main factors affecting labor productivity in a firm and then the amount of influence of each variable is measured and compared. The structure of the paper is as follows: The next section outlines the literature review and the theoretical framework on the most important determinants of labor productivity with the hypothesis testing. Section 3 provides information on the model, sample, describes the data and the variables used and gives the statistical analysis results. Section presents the regression results and section 5 concludes and gives some policy implications.

[1] Statistic center of Iran

2- Literature Review

There is extensive empirical literature on the factors affecting labor productivity. In most studies the dependent variable is labor productivity and the independent variables are physical capital, labor and knowledge capital. In this section each of these variables and Because of their influence on labor productivity will be introduced.

2-1- Education and Training

The important role of human capital in productivity growth is widely recognized in the economic literature since the seminal contributions of Schultz (1961), Becker (1964), Welch (1970) and Mincer (1974). According to the human capital theory, human capital contributes to output just like other factors of production and also through technological change by driving both innovation and imitation (Aggrey et al, 2010). Corvers (1997) discusses four effects of human capital on labor productivity: the 'worker effect', the 'allocative effect', the 'diffusion effect' and the 'research effect, he argues that human capital contributes to productivity level through allocative and worker effect, and productivity growth through diffusion and research effects. Corvers (1997) introduce these effects as follow:

The worker effect or 'own productivity' effect; this effect has been explained by Welch (1970). He assumes that firms produce only one good with the production factor education, and that other resources are given. The worker effect refers to the positive marginal productivity of education with respect to that particular good. Workers with a higher level of education are assumed to be more efficient in working with the resources at hand, i.e. these workers produce more physical output. In other words, education increases the effective labour input from the hours worked. Therefore a better educated labour force shifts the production possibility curve outwards.

The allocative effect; Points to the greater (allocative) efficiency of better educated workers in allocating all input factors to the production process (including education itself) between the alternative uses. Welch (1970) gives two examples of the allocative effect. If there is one fixed input factor to produce two goods, education may improve the total revenues of firms by means of a better allocation of the input factor between the alternative outputs. Although the production process is technically efficient because the firm produces on the production possibility curve (expressed in physical units), workers have more knowledge of how to maximize the marginal value product (expressed in money units) of the input factor. Total revenues are maximized if the marginal value product of the input factor is equalized for all goods. Another allocative effect is present if, in addition to education as an input factor, two (or more) other inputs are included in the production function. If just one good is produced with two inputs, education may also help to select the efficient quantities of inputs. In equilibrium the marginal value product of the inputs should equal the price of the inputs. In fact, education seems to provide the skills to make better decisions based

upon the available information.5 As a result of the allocative effect, an increase in the relative proportions of intermediate and highly-skilled is expected to lead to a higher productivity level in money units.

The diffusion effect; Stresses that better educated workers have more ability to adapt to technological change and will introduce new production techniques more quickly. Nelson and Phelps (1966) state that "educated people make good innovators, so that education speeds the process of technological diffusion" (see also Bartel and Lichtenberg, 1987). Moreover, Nelson and Phelps (1966) stress the role of receiving, decoding and understanding information in performing a job.6 A higher level of education increases the ability to discriminate between more and less profitable innovations and reduces the uncertainty about investment decisions with regard to new processes and products. Therefore education increases the probability of successful and early adoption of innovations. Higher proportions of intermediate and highly-skilled workers, relative to low skilled workers, would be expected to lead to more rapid and successful adoption of innovations and higher productivity growth.

The research effect; refers to the role of higher education as an important input factor in research and development (R&D) activities. R&D, in turn, is a key factor for technological progress and productivity growth (see, e.g., the endogenous growth models in Romer, 1990 and Grossman and Helpman, 1992). Since R&D activities are very complex, a relatively large proportion of intermediate and highly-skilled workers are a prerequisite to increase technological knowledge and achieve productivity growth.

Most of empirical studies in the field of education effect on productivity are conducted in industry level, for instance Tan and Batra (1995), have used industry data of several developing countries and shown that level of education and firm training have positive and significant effect on productivity. In another study Corvers (1996), discussed the effects of human capital on both the level and growth of labor productivity in manufacturing sectors in seven Member States of the European Union. The results of this study show that both intermediate and highly-skilled labor had a positive effect on the sectoral labor productivity level. A number of studies have estimated the impact of training on organizational productivity by using firm-level or establishment-level data. The studies of this type that are most frequently cited are Bishop (1991), Bartel (1994), Hozler et al. (1993), Huselid (1995), Almeida and Carneiro (2008), that their results indicate firm trainings have positive and significant effect on firm productivity. Black and Lynch (1996), used the data of more than 3000 privet establishments with more than 20 employees in united state, to study this issue. His findings show that the level of education has a positive and significant effect on productivity. Also the results indicated that the effect of labor trainings that provided by firm was positive and significant on productivity, and according to results, this effect was stronger than education effect. Turcotte and Rennison (2004) among industrial firms of Canada had the same results.

Aggrey et al. (2010) in their study used firm level data of African countries manufacturing and have shown that the effect of education and training on labor productivity was positive and significant.

2-2-Physical capital of firm

One of the most important physical capitals of firm that has been considered in empirical studies is to access information and communication technology such as computers, phone lines and internet and etc. Increasing physical capital of firm in the field of information and communication technology (ICT) lead to increased labor productivity. IT equipment will facilitate expansion of business process and information transaction between managers and employees and leads to increase in labor productivity (Papadogonas and Voulgaris, 2005). Berndt et al. (1992) in their study showed a negative effect of ICT equipment on labor productivity in industry level in the United States, while Lichtenberg (1993) and Brynjolfsson and Hitt (1995), using data of 500 firms in the United States showed that increased physical capital in the field of ICT leads to increase in labor productivity. Also Papadogonas and Voulgaris (2005), in their study of industrial firms in Greece have shown that increasing in capital equipment intensity causes labor productivity improvement.

2-3- Knowledge capital

Knowledge capital accounts for changes in productivity, which occurs because of new technology applications. In many studies, knowledge capital is the accumulated and still productive research capital derived from previous R&D expenditures [Griliches (1986), Hall and Mairesse (1995), Del Monte and Papagani (2003)]. In other studies, [Rogers and Tseng (2000)], "knowledge" is interpreted to include past investments in innovation, organizational techniques and human capital, in addition to R&D investment [Rogers and Tseng (2000)]. Despite these indexes, in most of studies R&D expenditures is used as a proxy of knowledge capital of firms. It is evident that as technology improves, the level of per worker output will increase, so any factor like R&D expenditures that causes technology improvement will increase labor productivity (Papadogonas and Voulgaris, 2005). There are many empirical studies that examined the effect of R&D expenditures on firm operation (sales, profitability and productivity)[2]. Papadogonas and Voulgaris (2005), have shown that among 3035 firms in Greece manufacturing sector, R&D expenditure had positive and significant effect on labor productivity.

2-4- Firm size

Industrial organization literature as well as relative theory support the view that small and medium sized-enterprises (SMEs) are less cost efficient than the larger ones, due to economies of scale, product differentiation, lack of R&D expenditures and lack of

[2] Griliches, 1986; Hall and Mairesse, 1995; Crépon *et al*., 1998; Lööf and Heshmati, 2002

vertical integration. Another reason for the lower efficiency is the large capital requirements in certain industry sectors. Since small firms have insufficient financing, they cannot grow to a large size-firm and benefit from economies of scale.(Papadogonas and Voulgaris, 2005). Empirical studies confirm this view, for instance Snodgrass and Biggs (1995) and Biesebroeck (2005) in developing countries and Van Ark and Monnikhof (1996), Baldwin et al. (2002), Baldwin and Gu (2003) and Leung et al. (2008) in some firms of developed countries have shown that firm size is positively related to labor productivity.

2-5- Firm export status

Based on existing studies there are two major reasons for a positive influence of firm export status on labor productivity:

Firstly, firms that export their products due to transport costs, marketing, distribution and etc, must have lower domestic price in order to determine a price commensurate with their costs and willingness to pay of foreign buyers for their exporting products. In other words, extra cost for sales in export markets will be as a barrier to prevent non-efficient firms' entry. Therefore, firms that export their products are expected to be more efficient and have more labor productivity than the firms that sell their products only in domestic markets. Secondly, firms that are attempting to export, enter into unwanted compete with other countries and can achieve a higher level of production knowledge through Learning-by-exporting process and improve their productivity (Wagner, 2005). Many empirical studies in different countries and in firm level indicate that being an exporter firm, has a positive effect on labor productivity, for inctanse: Bernard (1995), conducted his study for Mexico; Clerides et al. (1998) got the same result for Morocco. As well as studies of Lin et al. (1999), Aw and Hwang (1999) and Tsou et al. (2002) in Taiwan, and the study of Van Biesebroeck (2003) for nine African countries, confirm this idea. Moreover, the studies of Farinas and Martin-Marcos (2003) in Spain, Greenaway et al. (2003), Hansson and Lundin (2004) for Sweden, and Girma et al. (2004) in England and finally Papadogonas and Voulgaris (2005) among industrial firms in Greek have indicated that the labor productivity in exporter firms is more than no exporter firms.

2-6 - Firm ownership

Many economists believe that productivity and efficiency in the private sector is higher than public sector. Accordingly, privatization leads to increase of productivity and efficiency of firms; one of the major reasons for this is that state-owned enterprises are away from a competitive environment, because most of government agencies due to government subsidized protection have no incentives for competition (Parker and Martin, 1995). Other factors that cause low productivity for state-owned firms are:

- Government agencies have goals other than profit maximization.

- Management objectives in government agencies are often vague and not specified.
- It is difficult to define or justify the motivations.
- Ease of access to financial recourses by most of these firms leads to lack of financial discipline (Fraquelli and Erbetta, 2000).
- Bureaucracy and mismanagement

Employment of more skilled workforce by private enterprises makes them superior in terms of labor productivity (Barberis et al. (1996); Claessens and Djankov (1999); Gupta (2005)). Many empirical studies have investigated the effect of ownership of firms on their performance that Megginson and Netter(2001) have reviewed most of them to detail. Ehrlich et al. (1994) examined 23 firms in the field of air transportation, and their results show that firms with private ownership have more efficiency. Tian (2000) in China and Laurin and Bozec (2001) in Canada has achieved similar results, too. Among the numerous existing studies, Parker and Martin (1995) in England and Frydman et al. (1999) in East Europe countries paid more attention to labor productivity and had shown that labor productivity in private firms is much higher.

2-7 - Wage Level

Based on models of wage-efficiency, the wage rate above the market clearing level will increase labor productivity. Various reasons for this phenomenon is presented that can be divided in the form of two models:

- Incentives-driven model that is known as “Shirking model” according to this model, as wage level increases, labor force will be more motivated to keep their jobs and will therefore try to increase level of their productivity to avoid being deported.
- The “gift exchange” model is based on the assumption that high wages change the relationship between employer and employee. Employee will be more attached to employer and try to increase his own productivity (Mühlau and Lindenberg, 2003).

Many empirical studies confirming the wage-efficiency phenomenon, including Huang et al. (1998) for the industrial sector in China have shown that productivity change is effected by wage more than human capital. The study of Romaguera(*1991*) in Chile shows validity of the theory of wage-efficiency. Mühlau and Lindenberg (2003), using statistical data in Japan and the United States have confirmed this theory.

3 - Model

The model that is used in this study is similar to model of Papadogonas and Voulgaris (2005) that is designed to investigate the factors affecting labor productivity in Greece enterprises. This model can be expressed as follows:

$$LnLP_i = \alpha_0 + \alpha_1 LH_i + \alpha_2 TR_i + \alpha_3 LnK_i + \alpha_4 R_i + \alpha_5 LnS_i + \alpha_6 X_i + \alpha_7 O_i + \alpha_8 LnW_i + \mu_i \quad (1)$$

Where;

LnLP: is the logarithm of labor productivity. Moreover, labor productivity is the division of production value of each firm by its entire employees.

LH: is the ratio of employees with college or higher degree to total firm work force.

TR: is the ratio of employee training expenses to its total non-industrial expenditures.

LnK: is the logarithmic capital intensity. Capital intensity is the deviation of physical capital stock in to number of employees in the firm. Due to lack of access to statistical information at the level of ICT equipment of firms, in this study similar to Papadogonas and Voulgaris (2005), we used the physical capital intensity as an alternative criterion for capital equipment used in the field of ICT.

R: is a dummy variable to indicate the status of research and development in the firms. It will be equal to one if the firm has research and development unit, otherwise it will be equal to zero.

LnS: indicates the size of the firm and is equal to the logarithm of firm sales.

X: is a dummy variable to indicate the status of exporting in the firms. Its value will be one if the firm is an exporter one and otherwise it will be zero.

O: is a dummy variable to indicate the ownership status of the firm. The value of zero means that the firm is owned by public sector otherwise it will be equal to one.

LnW: is the logarithm of firm average payment per labor as their wage.

We have estimated this model as cross-sectional regression, using Eviews5 software. The statistical data are drawn out by Iran Statistical Center from the census plan of industrial workshops with 10 employees or more in 1386. That time totally 12,299 firms were active and counted in census.

4 -Empirical Analysis

In this section before estimating the model, we will descriptively analyze the relationship of some of labor productivity with the variables that introduced former using statistical data. The average labor productivity of two groups of firms is shown in table 1, one group has R&D units or costs and the other one does not. As the data indicate, the average productivity of firms with R&D expenses is higher than firms that do not have that cost. The same analysis about firm's ownership and export status is shown in tables 2 and 3. As the table 2 indicates, contrary to expectations privet ownership of firms does not have significant effect on labor productivity it means labor productivity in government agencies and non-government do not much different. Table 3 also shows that labor productivity in exporter firms is more than firms that are not exporter.

Table 1: R&D expenditures and labor productivity (million Rials per person)

R&D status in firms	Average of labor productivity
Firms with R&D expenses	442.89
Firms without R&D expenses	396.74

Table 2: Ownership status and labor productivity (million Rials per person)

Ownership status in firms	Average of labor productivity
Privet firms	423.61
Government Firms	442.89

Table 3: Export status and labor productivity (million Rials per person)

Export status in firms	Average of labor productivity
Non exporter firms	398.14
Exporter firms	449.89

Figure 1, indicates the relationship between the logarithm of labor productivity (LnLP) and the ratio of workforce with education associate degree and higher to total employees (LH). Scatter plot shows the existence of mild positive relationship between these two variables.

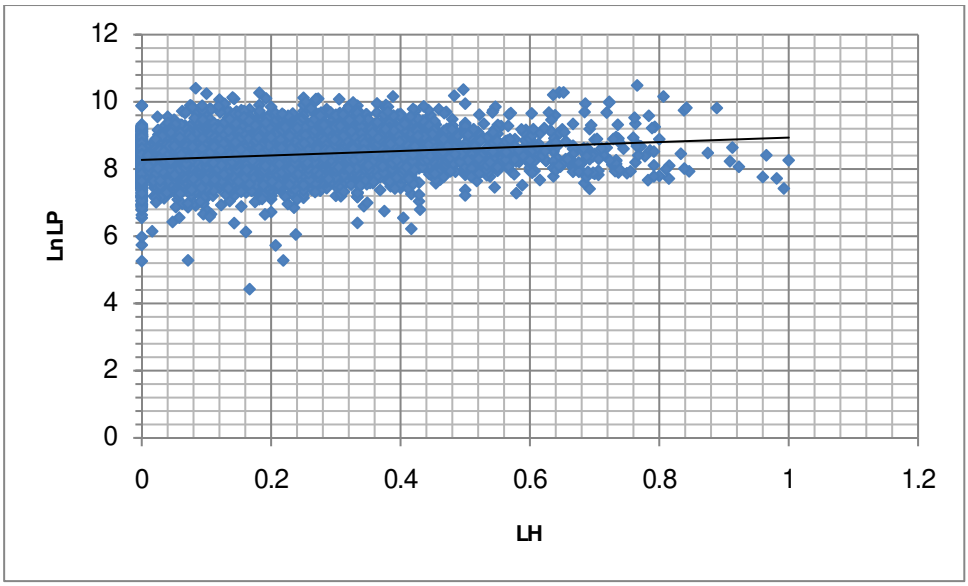

Figure 1: relationship between labor productivity and the ratio of educated workforce

After the initial analysis, we will estimate the model presented in the previous section. Estimation results of equation 1 are presented in Table 4. Based on the results, all coefficients are significant. Coefficient of *LH* is positive and significant and indicates that every one percent change in the ratio of workforce with education associate degree and higher will cause 0.33 percent increase in labor productivity. However, contrary to expectation, coefficient of *TR* is negative and significant, negative coefficient for this variable is due to inefficiency within the firm provided training to the employees. In other words, expenditure spent on labor training is not efficient and its positive effect in comparison with the costs spent on it is negligible. *LnK* positive coefficient indicates a positive effect of physical capital of ICT equipment on labor productivity in firm. Conforming the initial expectation, changes in firm size that measured by the number of employees has positive impact on firm productivity. This reflects that productivity is higher in larger firms. Among explanatory variables, the amount of wage payment (*LnW*) has the most significant coefficient; it means that labor productivity is affected mostly by amount of wage. This phenomenon represents the validity of wage-efficiency hypothesis among the industrial enterprises. The dummy variable for ownership status of enterprise has a significant and positive coefficient that indicates low labor productivity in firms with state ownership. However, the value of this coefficient is not very significant, indicating slight different of labor productivity in government and non-government agencies. The coefficient of dummy variable for R&D status is positive and indicates the positive effect of R&D spending growth on promotion of technology and labor productivity among the firms. The coefficient of export status also shows the importance of exports to international markets and new business development in technology improvement that results labor productivity increase. Although the coefficients of these two variables is low and shows little effect of them on labor

productivity , but this could be due to the low level of R&D expenditures and industrial exports. The coefficient of determination is not significant, but in comparison with similar empirical studies, it is acceptable. For example, in the study of Papadogonas and Voulgaris (2005) in Greece, the coefficient of determination was equal to 0.14.

Table 4: Estimation results of equation 1 using OLS approach

Variable	Coefficient	t-statistic
intercept	1.098534	6.146325*
LH	0.329499	12.02808*
TR	-0.610787	-3.447865*
LnK	0.213487	26.01026*
LnS	0.80767	8.213012*
LnW	0.693009	29.67538*
O	0.045444	2.234438**
R	0.043319	3.742196*
X	0.159233	12.33408*
Observation number	12299	
Adj. R^2	0.217962	
Log likelihood	-6060.981	
Akaike info criterion	0.987069	
F-statistic(Prob.)	429.4474 (0.000)	
Heteroscedasticity Test	276.3719 (0.0000)	

*: significant in level of 1%

**: significant in level of 5%

At the end of Table 4 the White Heteroscedasticity Test results is reported and according to value of statistic and probability level, existence of heteroscedasticity is confirmed. Despite the heteroscedasticity, although coefficients obtained from OLS method are still unbiased and will remain consistent but will not be efficient asymptotically. There are two methods for solving this problem: weighted least squares (WLS) and maximum likelihood estimation method (MLE). In this study, to ensure accuracy of conclusions based on the method of OLS, the model is estimated once more using MLE method and the result is reported in table 5. The results confirm the results obtained from using OLS method of estimation.

In this section to evaluate the stability of results, the model estimated once more after dividing the sample into two groups of small enterprises with 10 to 49 employees and large enterprises with 50 employees and greater, and the results reported in Table 6. Estimation results in small-scale enterprises show that the effect of *LH, LnK, LnS, LnW* and *X* still remain positive and significant, and effect of *TR* is negative and statistically significant but R&D expenditures and ownership status do not have a significant effect on labor productivity. However, in large firms the effect of these two variables is positive and significant.

Table 5: Estimation results of equation 1 using MLE approach

Variable	Coefficient	t-statistic
intercept	1.162618	7.297704*
LH	0.330636	12.85663*
TR	-0.601137	-3.791839*
LnK	0.211496	27.57211*
LnS	0.082014	8.558789*
LnW	0.686769	33.84739*
O	0.042996	2.527081**
R	0.043981	3.811948*
X	0.159688	12.41844*
Observation number	12299	
Log likelihood	-6117.456	
Akaike info criterion	0.996415	

*: significant in level of 1%

**: significant in level of 5%

Table 6: Estimation results of equation 1 separating small and large enterprises

Group	Enterprises with10-49 employees		Enterprises with50 and more employees	
Variable	**Coefficient**	**t-statistic**	**Coefficient**	**t-statistic**
intercept	0.985196	4.200326*	1.409356	5.064873
LH	0.277914	8.421861*	0.490708	9.788297*
TR	-0.383549	-1.840481**	-1.273625	-3.688785*
LnK	0.215769	20.22678*	0.209218	16.31566*
LnS	0.064521	2.786863*	0.076557	3.814366*
LnW	0.716856	23.68450*	0.650686	17.77604*
O	-0.015206	-0.463054***	0.084184	3.303481*
R	0.020085	1.126628***	0.060701	4.079001*
X	0.209448	9.965101*	0.126821	7.920564*
Observation number	8387		3912	
Adj. R^2	0.150724		0.282716	
Log likelihood	-4286.020		-1744.131	
Akaike info criterion	1.024209		0.896284	
F-statistic(Prob.)	187.367 (0.000)		429.4474 (0.000)	

*: significant in level of 1%

**: significant in level of 10%

***: insignificant

5-Conclusion

In present study the effects of different factors on labor productivity in industrial firms was investigated and the results that are according expectations are as follow:

1. While the education of work force has a significant positive effect on labor productivity, the effect of firm training expenditures was significant and negative. This demonstrates the inefficacy of trainings within the enterprise in comparison to trainings that they get before being hired. Based on this result we can have recommendations as follow:
    a. The importance of increasing educational level of work force in Iran
    b. The trainings within firms should be skill increasing and coordinated with the job needs of individuals.
2. Considering the positive effect of physical capital stock on productivity, it seems that investment in production facilities, especially in information and communication technology can increase labor productivity and thus productivity of whole industry.
3. Considering the positive effect of wages on labor productivity, paying more wages seems to be a good stimulus to promote labor productivity in industrial enterprises.
4. Positive effect of research and development costs on productivity highlights the need to pay more attention to creating and strengthening R&D units in firms. This issue is more important in large firms than in small firms.
5. Based on the results, firms with exports have more efficient work force. This indicates the importance of entering international markets to improve firms' performance. Therefore, encouraging firms to expand exports and facilitating industrial exports can increase labor productivity.
6. Because of significant and positive effect of private ownership on labor productivity in larger firms, transferring larger firms to privet sector can be more helpful in improvement of labor productivity than transferring small firms.

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