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Research Article

Differentiation in Differentiation Method and Neural Network to Investigate Different Criteria of Economic Productivity

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ABSTRACT

Economic productivity is one of the most important concepts in economics. Increasing economic productivity will boost a society. This study intends to compare the impact of different criteria on the economic productivity of Iranian factories with differential methods and neural networks. The model estimation results using the difference-in-difference method show that exports have a significant positive effect on productivity growth. The model estimation results using the neural network method show that export has a significant positive effect on productivity growth. The presentation of export development variables in two methods of difference in difference and neural networks showed that the level of productivity could be increased well according to the predictability of the neural network.

1. Introduction

Human needs for goods and services and the availability of resources used in their production limit. On the one hand, population growth increases demand and consumption. On the other hand, improving living standards increases the range of consumption needs on a large scale, while available resources are limited [1]. For this reason, in most developing countries, improving productivity is considered one of the most important factors of development. Iran is no exception to this rule, and due to the age composition of the population (young population) who are mainly the consumer population, the existence of a relatively high unemployment rate, underemployment, and hidden unemployment[2], lack of full capacity of production units, lack of Appropriate structures in most economic sectors and other cases, attention to improving productivity and promoting it at all levels as a basis for economic development and progress, is considered as an inevitable necessity [3-6].

According to the Europe Productivity Agency (EPA), productivity is the effective use of each factor of production. Japan Productivity Center (JPC) defines productivity as the maximum use of physical resources, human resources, and other factors of production in scientific ways so that productivity improvements reduce production costs, expand markets, increase employment, and raise living standards for all [7, 8]

One of the important sources of growth, which was in the sense of efficiency in the use of factors of production and expressed the combined effect of factors, is the growth of Total Factor Productivity (TFP). In general, enterprises (clothing production, textile production, publishing and printing, food and beverage industries, coal production industries, etc.) have a great desire to increase their productivity. The focus on productivity began in Europe (the late 1940s and early 1950s). This attention was due to the special situation of that time. Due to the devastation caused by the war in the affected countries, the demand was higher than the supply, so at that time, despite full employment, supply did not meet demand. Today, it is believed in all countries that productivity leads to economic growth and improves society's living standards and individuals [9].

With the help of modern and industrial methods, one can be called at the impact of each of the existing factors on the productivity of economic growth of Iranian factories. This article discusses the two methods: The Differentiation in Differentiation (DID) method and optimal artificial neural networks. Also, it will examine the impact of each of the existing factors on economic productivity and then compare the results based on statistical criteria [10-13].

The fundamental question is why it is necessary to measure the productivity index. There are several reasons for this necessity and can discuss various aspects of it, but in general the most important of these reasons can be summarized as follows [14]:

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1) Evaluate whether the highest return has been achieved or not? Every program needs to be evaluated, and it must assess that the results of decisions and policies have led to the desired results.

2) Recognize the strengths and weaknesses of the system by comparing and making the necessary corrections.

3) Control activities in the direction of the desired goals and apply various controls to improve system performance.

4) Adopting appropriate methods for effective use of resources and optimal use of facilities

5) Selecting the best method of activity and methods of the correct combination of factors of production and optimal allocation of economic resources.

In the second part of this article, the research background is presented, and in the third to fifth parts, the models are introduced, and at the end, the results of comparing the two models are presented.

2. Related Work

Better management can help reduce conflict, improve food security and increase economic productivity. Climate change is currently causing changes in the distribution and abundance of many fish stocks that support fisheries, leading to overfishing and conflicts resulting from changes in fisheries access and distribution of fishery benefits. As usual, if the trade continues, these problems are likely to worsen, with 80 percent of the world's reserves being overfished by the middle of the next decade [10-13]. More than 80 percent of the world's catch comes from stocks without formal inventory valuation, making it difficult to implement strong management forms. In addition, climate change introduces new types of challenges, such as introducing new species to fisheries. Strong political will, capacity building, and collective action are essential for developing fisheries management that is responsive and adaptable to climate change [15-17] .

Ohashi et al. (2017) worked on a model for improving economic productivity in South Korea. In the introduced model, he has used the data of 1980 so far. This model introduces an optimal productivity system that has increased efficiency among food retailers and supermarkets. The introduced model is finally compared with the other three models, which shows its efficiency with good efficiency [18].

Shahiduzzaman et al. (2014) examined the role of investment in information technology (IT) and described economic production and productivity in Australia for about four decades. The framework used in this paper is a general production function, in which IT capital is considered a separate input from production along with non-IT capital and labor. The experimental results of this study show evidence of strong technical progress in the Australian economy in the 1990s. IT capital has significantly impacted efficiency, labor productivity, and technological advances in the 1990s. However, in recent years, the share of IT capital in labor productivity and productivity has declined. As a result, the recycling of IT capital productivity, especially in future IT investment, remains a key challenge for Australia [19].

Datcher et al. (2012) organizations are increasingly becoming small to reduce costs and improve employee morale. There are conflicting reports about working outside the office on productivity, which directly affects the company's bottom line. This study examines the contradictions using an empirical approach. Used uniform and individual creative tasks were to explain two different work atmospheres. This study shows that the effects of a remote environment can have positive signs for creative task productivity and negative signs for uniform task productivity [20-22].

In economic change, employment, the combination of capital and technology, and market competitiveness are reflected. And exploitation is one of the effective factors in increasing productivity [23, 24].

In the general sense, productivity means the ratio of inputs to data. In other words, productivity means the average production per unit of total inputs, so that if the average production increases per unit of inputs, it means increasing interest. Productivity and vice versa mean reduced productivity. Depending on the type of input used in the production process, can define various productivity indicators [25].

In general, productivity indices are divided into two categories: partial productivity indices and total productivity indices. In partial productivity indices, the relationship between output and input is considered. In total production, the relationship between output and total inputs is examined. The productivity index is obtained by dividing the value added by a certain amount of input. It is necessary to use value-added at the fixed price of the base year. The productivity index of all factors (labor and capital together) is the output ratio to data. It represents the average production per unit of total production resources [26].

With the continued development of China's market economy, market competition has become increasingly fierce. In this regard, companies will face increasing problems. The financial crisis is undoubtedly the most important and biggest problem that threatens the survival and development of enterprises and is an inevitable problem for all enterprises. The technology of artificial neural networks is constantly evolving and improving with the advancement of science and technology. It has been shown to have significant performance for nonlinear data management, which warns of new ideas and technical support for corporate financial crises in advance. This article aims to investigate the disclosure of accounting information and financial crisis before warning based on artificial neural networks. Based on the artificial neural network BP learning algorithm, an accounting information disclosure test, and a previous financial crisis warning model were developed. With the help of this model, an accounting disclosure test and pre-crisis financial warning test were performed with company has a sample[27].

Due to the intense competition between countries for a larger share of world trade in the current situation, they try to provide Gross Domestic Product (GDP) growth or value-added sectors as easily as possible by improving structures. To increase the number of human resources, they try to increase the skill level of the employees by implementing specialized short-term training programs. Instead of creating new capacities, they try to equip the existing capacities with the latest technologies. In this way, they produce better quality products and increase their competitiveness [27].

3. Materials and Methods

3.1. Differentiation in Differentiation (DID) method

This method compares the conditions before and after a productivity variable. In this case, the changes revealed in the variable are due to changes in factors that occurred before and after a transformation. However, there are examples of units' subject to change, while other units are also randomly excluded and called control groups. The difference rate in both groups' income convergence is considered the difference in differences (DID). Now, suppose it is assumed that there are two types of companies. In that case, the first type of company participates in the export program over time, which will be active companies in

the export and are recorded as observed reactions. The second type of companies outside These is the groups that will be inactive companies in exports and are considered potential companies. This model has a balanced data set of independent and function variables that can define the primary variables. These variables are introduced by formulas 2 and 3 [11, 22, 25].

The total productivity growth rate of TFP factors is obtained from the following formula:

$$TFP=\eta_L APL + \eta_K APK \quad (1)$$

TFP is the productivity growth of total factors of production, APL is the growth of labor productivity, APK is the growth of capital productivity, η_K is the production elasticity of labor input, η_K is the production elasticity of capital input [11].

If the company is active in exports, one; otherwise, it is considered zero. (2)

If t = b, zero and otherwise $T_1 = 1$ $R_1 = 1$ (3)

In this case, the amount of participation in the productivity program can be calculated with Formula 4 [22].

$$D_{it} = R_i T_t \quad (4)$$

The result of defining the initial variables is obtaining two groups according to the initial variables and the efficiency of participating in the productivity program, which is given in formulas 1 to 3. According to these cases, can calculate the increase in productivity according to the difference-in-difference formula (formulas 5 and 6). Calculating the difference-in-difference method is different in the two cases of unobserved reactions and potential reactions, so it is given as two separate formulas [25].

A) Observed reactions

$$DID=E(y_b - y_a|R = 1) - E(y_b - y_a|R = 0) \quad (5)$$

B) Potential reactions

$$DID=E(y_{1b} - y_{0a}|R = 1) - E(y_{0b} - y_{0a}|R = 0) \quad (6)$$

By increasing or decreasing $E(y_{0b} - y_{0a}|R = 1)$, we can write the relation related to state "b":

$$DID=\{E(y_{1b} - y_{0a}|R = 1) - E(y_{0b} - y_{0a}|R = 1)\}$$
$$+\{E(y_{0b} - y_{0a}|R = 1) - E(y_{0b} - y_{0a}|R = 0)\} \quad (7)$$

Now imagine a situation in which there is an average of the same effect for non-member companies [22]:

$$E(y_{0b} - y_{0a}|R = 1) - E(y_{0b} - y_{0a}|R = 0) \Longrightarrow DID = E((y_{1b} - y_{0b}|R = 1) \quad (8)$$

So that DID determine the program's effect for group one at time t. In this case, because the parameter assumption is not created, DID is defined non-parametrically. In this case, $Y_{jit}$is a potential reaction (increase in productivity) for a company i (one of the two existing companies) at time t, so that j = 0 indicates non-participation and j = 1 indicates participation in exports, so the observation variable Not (Y_{jit}) is [11].

$$Y_{it} = (1 - D_{it})Y_{0it} + D_{it}Y_{1it} = (1 - R_i T_t)Y_{0it} + R_i T_t Y_{1it} \quad (9)$$

To get D, i must be deleted, which can be done to DID and formulas 5 and 6 since the DID shows only the program effect (export-induced transformation) for group one at time t and not for all regions. It can be developed within a linear model governed by even parametric conditions.

3.2. Neural network method

Neural networks can be called electronic models of the human brain's neural structure [28]. The mechanism of learning and training of the brain is based on experience. Electronic models of natural neural networks are based on the same model, and the way such models deal with problems differs from the computational methods typically used by computer systems. We know that even the simplest animal brains can solve problems that, if not to say that modern computers are incapable of solving them, at least have problems [29].

Experts generally believe that new computational models based on neural networks are shaping the next leap in the industry. Research has shown that the brain stores information like patterns. The process of storing information in a pattern and analyzing that pattern forms the basis of a new computational method. This field of computational knowledge does not use traditional programming methods and instead uses large networks that are arranged and trained in parallel [3].

An artificial neural network is an information processing idea inspired by the biological nervous system and processes information like the brain. The key element of this idea is the new structure of the information processing system. The system comprises many highly interconnected processing elements that work together to solve a problem. ANNs, like humans, learn by example. An ANN is set up to perform specific tasks, such as identifying patterns and categorizing information, during a learning process. Learning is accompanied by adjustments to the synaptic connections between nerves in biological systems [29].

A type of neural network is based on a computational unit called a perceptron. A perceptron takes vectors of inputs with real values and calculates a linear combination of these inputs. If the threshold value is higher, the perceptron output will be equal to 1; otherwise, it will be equal to -1.

This section introduces and uses a neural network Backpropagation. The characteristics obtained from the training data are entered into the network and examined in the test section. This network has used two hundred input neurons and two hidden layers. The job of hidden layer neurons is to process information and thus obtain a pattern to increase productivity. First, the training data is entered into the network, and then the average relative error is calculated using the Backpropagation method. The resulting error will affect the network weights, and eventually, weights will be obtained that can categorize the training samples correctly. Can evaluate test data with the help of a complete network. The input of the companies' export data network will be such that their economic productivity is specified [29].

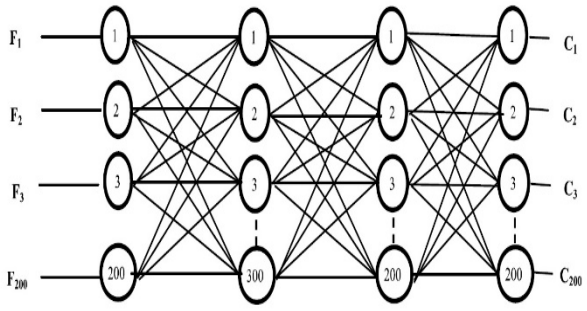

Fig. 1. Feed-Forward neural network

3.3. Statistical sources used

The statistics used in this article are extracted from the micro-statistics of the Industries and Mines Organization collected in different years. These statistics are collected from industrial workshops in a questionnaire every year. This questionnaire is organized into 12 pages and 13 sections. This information has been collected from 15,000 factories in Iran [30].

4. Results and experiments

In this section, the results of model estimation for the production function and the productivity function are discussed. The treatment effects model was used to estimate the model. The results presented in Table 1 with the z statistic indicate that the coefficient of the independent variable is significant at the level of ten percent. All obtained coefficients have the expected and good sign to accept the results obtained for the variables.

Table 1. Impact of variables using DID

Variable Name	modulus	Computational statistics	P-value
Export	2.22 e-13	1.19 e -13	**0/061**
Unskilled labor	-0.0000357	0.0000123	**0/00**
Treatment	7.625801	1.739849	**0/00**

Table 1 shows the effect of the desired variables on productivity using the DID model.

The first variable is exported, which positively affects company productivity and indicates increased productivity with increasing exports.

The next variable to be discussed is the unskilled labor force. As shown, it has a negative effect, which indicates a decrease in productivity with an increase in unskilled labor, which is quite true and natural because knowledge and technology is the most important force in promoting economic and industrial development.

The positivity and significance of variable 3 in Table 1 prove that exports increase the productivity of exporting companies and increase the productivity of other companies, proving the effect of learning through exports.

Table 2. Impact of non-workforce on treatment according to DID data

Variable Name	modulus	Computational statistics	P-value
Unskilled labor	-0.0000781	0.0000288	**0.091**

This table shows the effect of the unskilled labor variable on treatment. This variable's significant and negative coefficient indicates that increasing it reduces productivity in both exporting and non-exporting groups.

Now we need to estimate by another model to test the third hypothesis. The model presented here is an artificial neural network with two hidden layers. Neural networks can well estimate the required estimates. The estimated network is estimated using the MATLAB toolbox. And with the statistic l indicates that the coefficient of the independent variable is significant.

Table 3. Impact of variables using neural network

Variable Name	modulus	Computational statistics	P-value
Export	2.22 e-16	1.21 e-13	0/003
Unskilled labor	-0.000027	0.000041	0.000
Treatment	7.62586	1.73985	0.000

The positivity and significance of variable 3 in Table 3 prove that exports increase the productivity of exporting companies and increase the productivity of other companies, which proves the effect of learning through exports.

Table 4. Impact of non-workforce on treatment according to neural network data

Variable Name	modulus	Computational statistics	P-value
Unskilled labor	-0.0000510	0.000028	0.08

This table shows the effect of the unskilled labor variable on treatment. This variable's significant and negative coefficient indicates the effect of exports on productivity with positive and significant data of the exporting group. According to Table 3, it is clear that the critical level of export values has come down, and productivity has increased.

5. Conclusion

With the globalization of the economy, knowledge and technology are intensifying the demand for talent, physical resources, technology transfer, and investment in the world. In this regard, not only will high-tech industries be the engine of economic mobility, but also these industries will be an important comparative advantage for countries to remain in the global competition. One of the most important points is to calculate the productivity of companies in different periods. Many solutions have been proposed to evaluate the level of productivity. This article uses two methods of difference in difference and Moore's neural network. Using the difference-in-difference method, the model estimation results show that exports significantly affect productivity growth. The unskilled labor variable has a significant negative effect on productivity growth. Using the neural network method, the model estimation results show that exports significantly affect productivity growth. The unskilled labor variable has a significant negative effect on productivity growth. Increasing some indicators can help increase productivity. According to the research findings, it was found that the development of industries and thus increased exports will increase productivity in each country. The most important item that can help countries develop advanced industries is economic innovation to increase the number of exports and, consequently, the development of industries. Businesses need to be developed with the help of innovations. Innovative firms tend to gain more market share, create new products, and use more productive resources. Advanced firms depend on high value-added production and success in foreign markets.

Declaration of conflicting interests

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