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Investigating the Effect of R&D Intensity on Export Performance of Industrial Enterprises in Iran's Provinces

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Abstract
In today's world, non-oil exports contribute significantly to national economics. Empirical studies on exports show that enterprises' exports are affected by a variety of factors, including investment in R&D. However, exports of neighboring provinces are also influential. The present study investigates the effect of R&D intensity on the export performance of industrial enterprises in certain provinces of Iran during the years 2000-2015 using the spatial econometrics approach. The results of the study show that R&D intensity has a positive and significant effect on improving the export performance of industrial enterprises. Other explanatory variables such as the rate of economic growth, human capital, inflation, the size of industry and industrialization have also been examined, which prove to have a positive and significant effect on export performance of industrial enterprises.

Keywords: Exports of Industrial Enterprises, R&D Intensity, Iranian Provinces, Spatial Econometrics.

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1. Introduction

A retrospective analysis of developed countries reveals that they started producing various goods early on. But, over time, as their business expanded and competition from their rivals became compressing, they acquired more expertise in producing and exporting certain goods, resulting in more comparative advantage. There is also evidence that trade has a strong impact on national economic growth. Since mid-1950s, export development, especially the export of industrial goods, has always been one of the development strategies for third world countries. Export of industrial goods benefits national economic development as it is free of many restrictions imposed on the export of raw materials. In addition, in today's world, industrialization is a key indicator of economic development. Industrial exports play a very important role in the economic growth as they are more profitable, reduce economic dependence on oil revenues, facilitate manufacturers' access to new international markets and boost demands for domestic products, create more job opportunities and enhance value-added activities of national economy and its sub-sectors. In general, industrial exports from various channels such as foreign revenues, increased production, reduced average costs, economies of scale, exploitation of relative advantages, and learning by export, thus contributes to economic development.

Although in recent years the absolute value of industrial exports has increased, the share of industrial exports from the total export of the country has a fluctuating trend. Also, the share of total country exports to global exports has been steadily declining from 0.48% in 2013 to 0.35% in 2017, which indicates the weakness of the country's export in general and the weakness of industrial exports in particular, with the acceleration of global exports. The economic policies of successful countries are based on high value-added production.

Iran enjoys relative advantages in human and physical capital and has the potential to develop a model for industrialization (Strategic Plan of the Ministry of Industry, Mining and Trade,2016). Accordingly, investment in R&D to embed new sciences and technologies in to industrial sector, given the importance of industrial exports in economic development, is of great importance.

Investment in R&D helps in developing knowledge and technology, reforming processes, devising new working practices, providing new opportunities for entrepreneurship and business development, and improving export. Hence, manufacturing units and industrial enterprises are keen to create and develop R&D systems and invest in this sector to improve their systems. This leads to the formation of emerging technologies and business development.

The main function of R&D is to identify and solve problems of manufacturing units by utilizing scientific research and problem-solving processes and adopting new technologies for efficient manufacturing. This way, it helps promote economic indicators and organizational productivity. Economists assert that high growth rate in various economic and industrial sectors in developed countries is largely due to the fact that they rely on their research units to feed scientific findings and technological innovations into their manufacturing units.

The task of R&D in enterprises is to provide the knowledge needed to make effective decisions for production and trade with the lowest cost and the greatest benefit. In general, the role of R&D is to provide the knowledge of all decision makers in all sectors in order to make quick, effective, and beneficial decisions; therefore, R&D is the key to the competition and the achievement of modern technology in the world. Technology and its progress can change the nature of the production process and the quality of products in different countries, and improve the competitiveness of goods and increase their exports. If the infrastructure required to produce a product is subdivided into hardware, software, and human resources infrastructure, the experience of different countries shows that software and human resources are key determinants of international competition. In the current world, research and technology are recognized as the main indicators of the mobility and dynamism of a community.

Based on what we discussed above and positive impact of R&D on the export performance of industrial enterprises, and the fact that it is mostly neglected by researchers, the present study seeks to investigate the

impact of R&D on the export performance of industrial enterprises (with 10 or more working forces) in 28 provinces of Iran during 2000-2015, using the space econometric technique.

The rest of the study is organized as follows: first, a review of the literature of research is given, which includes theoretical foundation and experimental research background. Then, research methodology is explained including research model and data used. Section four analyzes the findings. Finally, the final section is dedicated to concluding and presenting policy proposals.

2. Theoretical Background

In this section, theoretical foundations of export is provided, followed by R&D. At the end, empirical background is discussed.

2-1. Theoretical Foundations

Business on its own is not a growth engine, but is a major driving force for many developing countries to achieve a higher levels of economic success. It provides the basis for specialization and exploiting economies of scale (Mitchell, 1988).Though business is defined in terms of exports and imports, export deserves more courtesy as it has a significant impact on development.

In general, there are two approaches to identifying determinants of export performance; 1) Initial production factors that determine relative advantage of an enterprise, 2) technology which has a relative advantage based on the quality of products and initial services. In this approach, export performance in terms of investment in applying new technology will lead to the development of new products (Ozliclik & Tymaz, 2000).

In general, there are several views on the factors affecting exports. Some emphasize the important role of price factors such as exchange rate, exchange and monetary policies and prices and they believe that price variables have the ability to provide non-quantifiable factors and conditions such as productivity, quality, and competitiveness. In fact, advocates of this approach consider price a regulator that compensates for all shortcomings. Other theorists emphasize on the high importance of non-profit factors such as productivity, competitiveness, labor management and production, technical progress, and quality element and discard price factors while relying on non-price solutions. There are still many who emphasize on both price and non-price factors with different weights and coefficients (Sharma, 2003).

Export performance is defined as the extent to which enterprise objectives to export a product by planning and implementing marketing strategies are realized. It is a multidimensional concept and cannot be explained by a single factor. It is linked with other stakeholders that depends on long- or short-terms objectives of the enterprise. Studies on export performance started in 1960s. Tookey (1964) was the first to identify factors on export performance. Later on, Aaby and Slater (1989), Wheeler, Ibeh and Dimitratos (2008), and Beleska- Spasova et al. (2011) proposed other models. A review of literature shows that export performance is a two-fold concept including exporters and non-exporters that are measured by tendency to export, engagement in exports and export intensity (Moshabbaki & Khademi, 2012, 101).

Experiences of economic growth in developed countries show that human capital and R&D have played a very important role in boosting their economic growth rates. Any shortcomings in production grow this no attributed to the small growth of labor and capital but to total productivity. This is what theories on endogenous and exogenous growth rely in explaining the dominant factors.

The endogenous growth patterns on R&D are presented by economists such as Romer (1990), Grossman and Hellman (1991). Romer states that investment in R&D results in manufacturing new products.

In the endogenous growth models, the role of R&D has been emphasized as the engine of economic growth. R&D allows new capital goods to be introduced that may have a greater and better role in producing than existing capital goods. It also helps economic growth by contributing to existing science and knowledge.

At the moment, creativity, and innovation are among the greatest assets of today's world-class enterprises and industrial centers; therefore, in most factories and almost all European and American companies, there is a special section called R&D that is responsible

for reviewing examples and ideas and working on new creations and innovations of the day.

In a comprehensive definition, R&D is described as a set of innovative, systematic and planned activities aimed at expanding the boundaries of scientific knowledge and treasures of human knowledge and the human community and the application of this knowledge in various fields to improve human life and, in brief, for innovation, the creation of products, processes, tools, systems, services and new methods is defined (Maknon, 1998).

Baldwin and Gu (2004) showed that investment in R&D reinforces the relationship between exports and production. Di Cintio, Ghosh, and Grassi (2017) also contend that R&D influences exports and, consequently, enhances employment in society. R&D is nowadays recognized as the most important factor for economic development and success of enterprises and countries in the field of global competition in trade and economy.

Economists believe that science and technology as a powerful tool can play a key role in the development process. In the current world, developed countries benefit from high levels of science and technology. Hence, many of the products, methods, tools and advanced technologies stem from such countries in the field of science and knowledge. Studies on developed countries indicate that high rates of growth in these countries is driven by a wide range of technological innovations.

Technology accounts for a great deal of success stories in different enterprises. R&D is the key to competitiveness and success in the modern world of technologies. Technology changes the nature of production process and quality, and improves product competitiveness as well as exports.

The task of R&D in the economic and industrial enterprises is to provide the knowledge needed to make effective, important and better decisions for production and business with the lowest cost and highest profitability. In general, R&D provides the knowledge needed by all decision-makers in all sectors, including industrial sectors, in order to make quick, effective and beneficial decisions. Success in R&D distinguishes an industrial enterprise from innovating products, processes, and practices compared to other competitors and provides the ground for developing entrepreneurial capacities and, consequently, the growth of economic indicators in that enterprise.

The theoretical foundations presented in this study are very similar to those developed by Clerides et al. (1998), Melitz (2003) and Atkeson and Burstein (2007). Enterprises are assumed to be heterogeneous in export performance and this is used as an incentive to invest in R&D to improve exports.

R&D investment can lead to a different export performance for enterprises. Decision-making for enterprises is a two-part process: static and dynamic; Static sector: The productivity of the enterprise determines its profitability in the export sector and the dynamic section identifies investment in the R&D department of the enterprise to optimize its export using participatory decisions. Then, dynamic decisions are made in regard to exports and investment in R&D.

The entry of the enterprise into the export market brings about irrecoverable costs for that enterprise. It means that export of the previous period as the state variable affects the enterprise's export decision-making process. This is known as the basic theory for providing a dynamic export model by Roberts and Tybout (1997) and Das, Mark, and James (2007). As it is seen in equation (1), the export of enterprises and investments in the R&D sector can affect the future state of affairs of enterprises(x).

$$x = g(p, d, e) + \varepsilon \quad (1)$$

$$x = \alpha_0 + \alpha_1 P + \alpha_2 (P)^2 + \alpha_3 (P)^3 + \alpha_4 d + \alpha_5 e + \alpha_6 d e + \varepsilon_{it}$$

P is the enterprise productivity in the previous period, d is enterprise investment in R&D department in the previous period, e shows share of the enterprise in the export market in the previous period, and ε_{it} is a shock with a mean of zero and a constant variance δ_ε^2. The second line shows the operational form: the interrupted relationships of productivity and interaction between the interruption of exports and investment in the R&D sector. The variable d shows that the enterprise can influence its productivity assessment by investing in the R&D. e sector shows experience with export; in other words, participation in the export market is considered

as a source for learning and skills in improving the future productivity of the enterprise. d and e are considered dynamic variables that represent investment in and earnings from R&D sector.

In empirical models such as Roberts and Van (2013), these variables are considered separately. They found that the productivity of Taiwan's electronic products was influenced by the activities of enterprises in the export and investment sectors of R&D. They also observed evidence of poor correlation between productivity and investment in R&D and sales of export markets. However, some of these variables were considered as virtual variables, whether or not the enterprise has invested in the R&D sector. While incomes of the export sector of the industrial enterprises are important factors in the decision making of enterprises to invest in R&D, it affects the composition of enterprises in the competitive market, and its fixed and variable costs.

One of the key assumptions in enterprise decision making is prioritizing exports and investment in R&D. It is assumed that enterprises are initially aware of fixed (γ_{it}^{F}) and the variable (γ_{it}^{s}) costs of exports and decide separately for the export of the year (t). Following this, the fixed cost value (γ_{it}^{I}) of the investment sector leads to the decision to invest in the R&D sector. It is assumed that all three types of costs are subject to a single distribution.

The value of enterprise performance in year t before estimation of fixed and variable costs is as follows:

$$v_{it}(z_{it}, k_i, \varphi_t, x_{it}, e_{it-1}) = \int (\pi_{it}^{D} + \max_{e_{it}}\left((\pi_{it}^{X} - \gamma_{it}^{F} - (e_{it-1} = 0)\gamma_{it}^{s}) + V_{it}^{E}, V_{it}^{D}\right))dG^{\gamma} \quad (2)$$

Z_{it} is the export of demand shocks, which was the first stage of the Markov process and K_i is the capital accumulation enterprise φ_i is the virtual variable X_{it} is the enterprise productivity and e_{it-1} is the share of the enterprise in the export market in the previous period. Where V_{it}^{E} is the value of the enterprise's exports after the optimal choice of investment in the R&D sector. Similarly, V_{it}^{D} is the non-affiliated company's value after selecting the optimal investment in the R&D sector. This equation indicates that the enterprises' decision to export in year t is carried out, in addition to realizing the expected future profits, the export earnings are higher than fixed and variable costs of the enterprise. Here, the value of investment in R&D is seen in two variables of V_{it}^{E} and V_{it}^{D}. Specifically:

$$V_{it}^{E} = \int \max_{d_{it}\in(0,1)}(\delta E_t V_{it+1}(.|e_{it} = 1, d_{it} = 1) - \gamma_{it}^{I}, \delta E_t V_{it+1}(.|e_{it} = 1, d_{it} = 0)dG^{\gamma^{I}} \quad (3)$$

The first section shows that if an enterprise decides to invest in R&D (d_{it}=1) and pay for current costs of this decision, it expects to regain the costs by future income. However, it depends on how investment in R&D influences the enterprise's future status. Otherwise, if the enterprise ignores investment in R&D (d_{it}=0), it will have a different production and export path. The greater the impact of investment in R&D on the enterprise's future status, the greater the difference between expected profits in enterprise's investment in R&D and a situation in which investment in this sector is not made.

Similarly, the value of investment in R&D in non-exporting enterprises is as follows:

$$V_{it}^{D} = \int \max_{d_{it}\in(0,1)}(\delta E_t V_{it+1}(.|e_{it} = 0, d_{it} = 1) - \gamma_{it}^{I}, \delta E_t V_{it+1}(.|e_{it} = 0, d_{it} = 0)dG^{\gamma^{I}} \quad (4)$$

In this case, the enterprise will face the same situation, but the future direction of the enterprise will not be exports-based and the value of the expected future earnings depend on the selected e_{it} and d_{it}.

$$E_t V_{it+1} = \int_{\varphi`} \int_{z`} \int_{x`} V_{it+1}(.|e_{it}(dF(x`|x_{it}, e_{it}, d_{it})dF(z`|Z)dG(\varphi`|\varphi) \quad (5)$$

Where V_{it+1} depends on e_{it}, because of input costs. The evaluation of enterprise productivity and export depends on the two

variables e_{it} and d_{it} due to the assumption mentioned in equation (1). The specific situation of the model is where export costs are always zero and exports do not affect the enterprise's status. In this situation export is assumed as a fixed decision and $V_{it}^{D} = V_{it}^{E}$, and the exporting and non-exporting enterprises will have a similar assessment of investment in the R&D sector. This model shows that if there are input costs, exporters of investment valuation will have a different level of R&D for non-exporters.

Enterprises are different in terms of the past situation of exports, investment in stocks, productivity, and export demand. These variables affect the short-term benefit of enterprises and their export status. The decision of enterprises affects the status of future productivity and investment income in the R&D sector. This process involves combining variable export costs and fixed costs of R&D investment, determining the optimal choice of enterprise's exports, investing in R&D, or non-investing in this sector.

2-2. Empirical Research Background

In the context of the impact of R&D costs on exports, extensive studies have been conducted. In an article titled 'Export Behavior of Manufacturing Companies in the Nineties: The role of innovation, the effect of R&D costs and advertising on the export of Italian manufacturing enterprises during 1991-1997', Basile (2001) performed an analysis using the panel data method. The results of the research show that R&D costs and advertising costs have a positive and significant effect on the export of manufacturing enterprises.

Yoon (2004),'Structure and Performance in Korean Manufacturing Industries', examined the impact of R&D costs, the cost of advertising degree of concentration on exports of South Korean manufacturing enterprises in the years 1995 to 2002 using panel data. His research results show that R&D costs and advertising costs have a positive effect on the export performance of manufacturing enterprises.

Yang & Chen (2011),'R&D, Productivity and Export at the Indonesian-based industry', examined the effect of R&D costs and the growth of labor productivity on Indonesian manufacturing exports during 1991-2008 using a panel data method. The results of the study show that the growth of labor productivity and R&D costs have a positive effect on the export performance of enterprises.

In a paper titled 'R&D and Innovation on High-Tech Exports', Sandu and Ciocanel (2014) investigated the effect of investment intensity in R&D on manufacturing exports in EU member states in the years 2006-2010 using Flat panel data and reported that private sector investment in R&D has a stronger effect, than public sector, on improving exports of EU countries.

Dzhumashev, Mishra, and Smyth (2016),'Exports, investing in R&D and survival of active companies in India's Information and Technology Division', examined the impact of R&D costs on the survival of Indian information companies between 1991 and 2009 among 797 companies using the panel data method. The results of the study show that investment in R&D and export sectors has been effective in the survival of the companies studied.

In a paper titled 'Relationship between Uncertainty, Labor Force and R&D Costs', Di Cintio et al. (2017), examined the impact of R&D and export costs on the growth of employment in manufacturing industries in Italy between 2001 and 2007, using synchronous, seemingly unrelated equations. The results of the study show that R&D costs lead to increased employment while R&D-induced exports lead to negative growth of employment.

Li and Lu (2018),'R&D, China's Fiscal Financing and Export Restrictions', reviewed the impact of R&D on Chinese exports between 2000 and 2007 using panel data method. The results of the study indicate that the financial constraints and costs of R&D have affected China's industrial exports.

Nazari and Zamani (2006) studied the Effect of R&D Investments on the Export of Industrial Activity by the ISIC Dates, during the years 2004-2013, in the framework of a Multivariate Econometric Model, Using the panel data method. The authors asserted that R&D expenditures in five codes (code 17 of textiles production, code 21 of paper and paper products, code 29 of unclassified machinery

and equipment, code 31, which integrates office machinery and accounting and production of generating and transmission machines, code 32 radio and television production) are effective on exports, but reported no relationship between other codes and exports.

Mobarak (2010), in an article titled 'R&D investment in exports in Iran', examined the impact of R&D expenditures on the export of industrial activities in nine industrial groups with ISIC codes from 1995- 2007 using panel data method. The results of the study show that R&D expenditures in some industries such as textiles and clothing, wood and wood products, paper, printing and publishing industries have a positive effect and in some industries such as metal industries, miscellaneous industries, food industries, Tobacco have been ineffective.

Salmani and Abdi (2014),'The Effects of Domestic R&D and Import of Technology on Food and Beverage Industries Exports in Iran', investigated the effect of R&D on the export of 23 food and beverage industrial sub-categories at the level of 4-digit ISIC code over the years 2000-2007using panel data method. The results of the study indicate that R&D has a positive and significant effect on exports of this group.

Dehghani and Sheikh (2016),'The Relationship Between Advertising, Research and Export in the Manufacturing of Wooden Products in Iran' (Approach to the seemingly unrelated regression equation system), investigated the interrelationship between R&D costs and the export of Iran's wood production market during the years 2005-2011, at the level of 4-digit ISIC codes. They used synchronous, seemingly unrelated equations. The results of the study show that R&D costs have a positive effect on the export of the country's wood industry.

Dehghani and Sheikh (2016) studied effectiveness of R&D costs on the profitability of industries and cooperative firms in Khorasan province during 1995-2002 by 133 4-digit ISIC codes and reported positive effects.

Rahnamayeh Gara Melki , Motefakerazad and Rajpour (2016) evaluated effects of domestic investment in R&D on value-added on high-tech industries in Iran's provinces during 1995-2010 using panel data. Results showed that investment in R&D has positive and significant effects on value-added of industries.

Mohammadzadeh, Seifipour and Mehrabian (2018) studied effects of R&D on economic growth in high-income and average-income countries using quantile regression during 1996-2013 and showed that R&D costs are positively correlated with GDP.

To the best of the author's knowledge, the impact of R&D costs on the export performance of industrial enterprises in the provinces of Iran has mostly remained unobserved. Moreover, effects of industrialization on exports performance of industrial enterprises in Iran have not been studied so far. Thus, with an eye to effects of neighboring provinces, the present study examines the effect of R&D costs on the export performance of industrial enterprises in Iran using spatial econometric techniques during the period of 2000-2015.

3.Methodology

This is an applied and analytic research. The statistics and information required for the research are collected by documentary and library method. The statistical values are annual logarithms for the period of 2000-2015. In this research, the spatial econometrics method is used to investigate the effect of R&D costs on the export performance of industrial enterprises; for this purpose, Excel and Stata13 software are used. Based on theoretical foundations and empirical studies carried out in this field by Dzhumashev et al. (2016) and Cintio et al. (2017), the empirical model of this study is presented in equation (6):

$$EP_{i\,t} = \alpha_i + \beta_1 DR\&D_{i\,t} + \beta_2 EG_{it} + \beta_3 IR_{it} + \beta_4 HC_{it} + \beta_5 IS_{it} + \beta_6 I_{it} + e_{i\,t} \quad (6)$$

Where i and t represent provinces and year respectively, and the variables used are logarithmically taken from the annual reports of the Iranian Statistical Center and Statistical results of industrial enterprises with 10 or more employees.

α_i: is a fixed provincial effect that includes unrecognized and invisible variable such as cultures, institutions, ethnicity, religion, climatic conditions, etc., that affect the export

performance of provinces. (EP_{it}) is the dependent variable of export performance which is calculated as the ratio of the value of the export of industrial workshops to ten employees and most of the provinces of the country to their sales value. DR&D is the intensity of research and development of industrial enterprises with ten employees and most of the country's provinces, which are considered as a successor variable through the collection of research costs and labs which is calculated from the ratio of R&D costs to the value of sales. Considering theoretical foundations and empirical studies, investment in R&D is expected to improve export performance. Investing in this area will lead to increased performance of enterprises. Employment is highly affected by investment in R&D. For example, employment in handicrafts sector is sharply decreasing. EG is economic growth rate, which calculates the growth rate of production in each province during the study. The rate of economic growth in the form of calculations, per capita or in absolute terms, indicates the economic capacity of the country, the size of the economy and the economic context of a field of economic activity. With its increase, it is expected that the country will be able to absorb and produce more products, and subsequently export performance will increase. IR is domestic inflation rate calculated based on the consumer index (CPI) of the country's provinces. With the increase in inflation, the export performance of industrial enterprises is expected to improve, because with the increase of the exchange rate and the reduction of domestic money, domestic goods are cheaper for foreign users and the purchasing power of foreign consumers for domestic goods is higher. In other words, the upward curve of the curve J is better in this situation and a country that is facing a devaluation of the domestic currency will use this policy to set the potential losses caused by the decline in the credibility of the domestic currency. HC is human capital derived from the ratio of literate workers of the industrial enterprises with 10 or more workers in the provinces to the entire workforce in the country. It is expected that human capital and literate workforce will have a positive effect on the export performance of enterprises. This is because practitioners and employers favor specialization and this is enhanced by providing management training, specialized training in software, foreign language training, and training in marketing related skills. I is the size of the industry segment, which derives from the value-added ratio of the industry to the value added of the entire province and is expected to have a positive impact on the export performance of industrial enterprises, i is the industrial dummy variable which is calculated by using the numerical Taxonomic Method and considering three indexes of capital formation in industrial enterprises with ten or more employees in each province, value added of the industrial sector of the provinces, and total number of employees in the industrial enterprises with ten or more employees in each province. Industrial provinces are assigned number one and non-industrial provinces are zero. It is expected that industrialization of the provinces will have a positive effect on improving the export performance of industrial enterprises.

One of the methods for grading the regions in terms of development is Taxonomic analysis. Taxonomic analysis is used for different categories in different disciplines. A special number is a numerical Taxonomic. A numerical Taxonomic is used to assess the similarities between Taxonomic units and their ranking. This methodology is an excellent method of grading, classifying and comparing different regions according to their degree of development and modernity. It is also a method that divides a set into homogeneous sub-sets and provides a reasonable scale for evaluating the extent of development of the areas available to the planners. In this method, one of the studied points is usually chosen as the ideal point or region, ranking points or other areas based on it. Thus, the difference or distance of each region is determined by that ideal region.

Considering that the exchange rate was one of the factors affecting the flow of exports and its constant value in all examined sections, it is excluded from model.

Spatial econometrics was first presented by Professor Anselin. Anselin (1988) claimed that spatial econometrics are more reliable than common econometrics in regional studies. One of the most important difference between spatial econometrics and common

econometrics is that spatial econometrics consider Spatial Dependence and Spatial Heterogeneity. These two problems, which are neglected in the traditional econometrics, violate the Gauss-Markov assumptions (Masoomzadeh, Shirafkan, & Sayyareh, 2017).

Spatial Dependence is a phenomenon that occurs in spatial sample data. That is to say, observing a location i is dependent on other observations in location j, assuming $i \neq j$. Spatial dependence can occur between multiple observations; i can take any value between 1 and n, because it is expected that the sample data observed at a point in space is dependent on the values observed in other places (Asgari & Akbari, 2001: 98). The heterogeneity of variance also refers to the deviation in the relationship between observations at the level of the geographical points of space; it means when moving between data collection observations, the sample data will not have a stable mean and variance (Najafi Alamdarlo, Mortazavi & Shamshadi Yazdi, 2012: 54).

Regarding the effect of location in Iranian provinces and the proximity effect, the patterns used are based on the spatial econometric method with spatial map data. Therefore, Spatial Weight Matrix is based on the economic distance between the provinces by a property method that expresses the dependence between the provinces. The proximity matrix elements are zero and one (Lesage & Pace, 2009). More precisely, spatial econometrics are sub-branches of econometrics which deals with spatial interrelationships (Spatial Dependence) and spatial structure (heterogeneity) in regression models with cross-sectional data or cross-sectional-time series combinations and with different stipulations of the models, these issues are taken into consideration. In spatial econometric models, maximum likelihood (ML) methods are used to estimate model parameters. Using this method leads to unconstrained and consistent estimates (Lesage & Pace, 2009: 20). In order to estimate the model, Spatial Auto Correlation model (SAC) has been used among different methods of spatial estimation. Which includes the dependent spatial interruption and disrupted components. This model is shown in relation (1):

$$y = \rho W y + \alpha l_n + X\beta + u$$
$$u = \theta W u + \varepsilon$$
$$\varepsilon \sim N(0, \sigma^2 I_n)$$

In this model, the parameter indicates the interruption of the spatial interruption of components (Lesage & Pace, 2009: 20).

4. Empirical results

In this section, an estimation of the dynamic effect of the intensity of R&D costs on the export performance of industrial enterprises in Iranian provinces is discussed. Since ordinary regression models ignore the dependence of spatial observations, spatial regression models are used to estimate the model. Therefore, proximity matrix is made by considering the economy for 28 provinces (according to the separation of the provinces of Alborz and Khorasan; the provinces included in this study are 28 provinces); Thus, considering effects of competition on the pattern of household consumption and its contribution to raising the costs of urban households, weighted matrix is used to estimate this model on the basis of neighborhood and property method. Values of 0 and 1 are assigned to non-adjacent and adjacent provinces, respectively.

In the next step, in order to define spatial weighted matrix, the first-order standardized proximity matrix has been used. In this matrix, standardization is based on the sum of each row of the proximity matrix. The spatial weighted matrix for this study will be matrix 420 *420 for 28 provinces and the time period studied. H_0 of Moran test and LM Error Lack of Spatial Dependence in disruptive components are in the observations of the dependent variables (Lesage& Pace, 2009: 2). In addition to performing these two tests, it is necessary to perform the tests of LM error-robust and LM Lag-robust so that the results of the tests are evaluated with higher efficiency. Also, it is necessary to select Spatial Error Models (SEM), Spatial Auto Regression (SAR) or Spatial Auto Correlation (SAC) model to resolve the self-correlation in the components of the disturbance, which is done by means of Lagrange coefficient tests. Then the proposed equation is estimated by the chosen model. If the H_0 based on the lack of Spatial Dependence in the components of

disturbance is rejected, the spatial error model will be used, and if the H_0 based on the lack of Spatial Dependence of observation of dependent variables of the complex regression model is rejected spatial regression itself will be used. But in the case that both H_0 are rejected, the model of the public space is used to estimate the model.

Table 1. Results of diagnostic tests to select the optimal model

Variables	value	Degree	statistical probability
Test LM) χ^2(	226.9396	1	0.000
Test Moran) Z(	-1.0693	1	0.0139
Test LM Lag Anselin)χ^2(	8.0179	1	0.0046
Test LM SAC) χ^2(	9.2425	1	0.0091
LR test for choosing SAC model versus OLS (χ ^ 2)	35.8424	2	0.000
Test LM error-robust	6.7893	2	0.004
Test LM lag-robust	8.017	2	0.0046

Source: Research findings

The results of the LM test shows that the H_0 based on the insignificance of spatial dependence between observations at 1% level is rejected and so the spatial dependence between the observations is confirmed. The results of the Moran test also indicate that the H0 based on the lack of spatial dependence among disrupted sentences in the 1% level is rejected, signifying spatial dependence among them. The LM SAC test examines the overall spatial dependence in the model and the results show H_0 is rejected at 1% significance level. The result of the LM Lag test with H_0, no spatial dependence for the dependent variable, indicates that $H_0$is rejected at the 1% level.

Due to the larger size of the LM error and LM error-robust, LM Lag and LM Lag-robust tests, the critical value of 6.635, the spatial error and mixed regression-autoregressive error model should be used for estimation. So, an estimate of the general spatial model, which includes both models, is used. Also, the result of the LR test for choosing SAC model versus OLS shows that SAC model is the best model to investigate the effect of R&D intensity on the export performance of industrial enterprises.

Table (2): Model estimation

Variable	Coefficient	statistics t	p> t
Ldr&d	0.1883581	3.54	0.000
Leg	0.0843958	1.61	0.108
Lhc	0.163818	3.79	0.000
Lir	2.429231	3.04	0.002
Li	52.07463	4.07	0.000
Lis	14.23866	2.32	0.020
Cons	47.68704	3.02	0.003

References: Research calculations

According to the results of Table (2), it can be seen that R&D intensity has a positive effect on the export performance of industrial enterprises (0.1883581). In other words, increased R&D intensity increases the performance of the industrial enterprises by 0.18%. This variable is also statistically significant at 1% level. R&D is found to be an influential factor in the literature, especially in developed countries with high levels of exports, and it has received great attention. The role of R&D in enhancing industrial exports and competitive advantage in international markets is significant. This leads to quality products, more innovative ways of production, and competitiveness. When an enterprise manufactures new products, it gains an exclusive position in national as well as international markets. Human capital has a positive effect on the export performance of industrial enterprises. Increasing the number of educated workers to the total industrial sector workers, increases export performance by 0.163818% and this variable is statistically significant at 1% level. Rising inflation will increase export performance of industrial enterprises such that 1% increase in inflation rate increases export performance by 2.429231% and this variable is statistically significant at 1% level. The positive effect of this variable is explained by the fact that with the increase of currency credibility and the devaluation of the domestic currency, the export goods of the industrial sector are cheaper for foreigners and the purchasing power of foreign consumers to buy goods from Iran is higher and this situation can be used as an advantage to offset the losses of the domestic currency. Economic growth also has a positive effect on the improvement of the export performance of industrial enterprises, with a one percent increase in the GDP per

capita growth rate, the export performance of industrial enterprises increases by 0.0843958 percent, and this variable is statistically significant at the level of 1%. In other words, with increasing economic growth, the country's power in domestic production and gaining competitive power in the international arena will increase. High education of human capital significantly affects exports performance of industrial enterprises. Skilled and experienced staff is a guarantee of creativity, innovation, and high-tech exports and helps improve industrial trade. Industrialization of the provinces as a dummy variable has a positive effect on the export performance of industrial enterprises (52.07463). In other words, industrial enterprises are expected to have a better export performance in industrialized provinces. This coefficient is statistically significant at 1% level. The size of the industrial sector also has a positive impact on the export performance of industrial enterprises (14.23866) and this coefficient is significant at a significant level of 5%. In other words, by increasing the ratio of the value added of the industrial sector to the total value added by one percent, the export performance of industrial enterprises increases to 14%. Big industries have higher competitiveness in international markets. This is because factors such as shipping costs and international standards make it hard for enterprises to enter international markets and only large-scale enterprises can survive. Factors such as economies of scale, specialization, availability of low-cost finance and high risk-taking capacity justify positive effects of industry size on exports performance of enterprises.

5.*Conclusion*

This study investigates the effect of investment in R&D on the export performance of industrial enterprises in the provinces of Iran during 2000-2015 using the spatial econometrics method and Stata 13 software. The results of the study indicate that the R&D intensity leads to an increase in the export performance of industrial enterprises, and this variable is statistically significant. Most industries in the exporting countries have well-equipped R&D laboratories. The role of R&D in strengthening the export industry of the industries in terms of their competitive position in foreign markets and creating a monopoly position is justified. The experiments conducted in these laboratories lead to the superiority of product quality, either the invention of new methods, or the improvement of the production technology, and the competitive ability and exportability of these industries increases. If the result of this research is to create a new product, it will bring an exclusive position for these industries in national and international markets. In this case, the intensity of R&D will improve the export process. In addition to this variable, the effect of some explanatory variables such as advertising costs, human capital, economic growth, inflation rate, distance and total industry expenditures have been investigated on the export performance of industrial enterprises. All of these variables have had a positive and significant effect on the export performance of industrial enterprises. Therefore, according to the results, fluctuations in oil price and scarcity of oil source, it is suggested that policy makers set it as their agenda the plan for a non-oil exports to speed up developments.

Considering the positive effect of the R&D intensity on the export performance of industrial enterprises, it is suggested that the government invests in education and learning, protect intellectual property rights, and foster competition to develop innovative platforms of activity. These costs can be invested in sectors such as government research, investment, business, human capital formation, intellectual property protection laws and tax credits. Investment in R&D facilitates creativity and adopting technological advances in industrial subscales. The government can enhance international economic ties to facilitate imports and help boost enterprise exports.

Considering positive effects of the Dummy variable of industrialization on export performance of industrial enterprises, it is suggested that the government identifies and improves provinces with proper industrial infrastructures. On the other hand, inflation rate is found to have positive effects on export performance and it is suggested that policymakers seize inflation rate and increased exchange rate as an opportunity to boost business flow and improve enterprise exports to enhance national competitiveness in the

region. This is possible by allocating exports subsides or promotions.

Increasing the proportion of educated employees to the entire industry will lead to an increase in service delivery, productivity, profitability, improved enterprise performance and improved service and product quality. Based on this, it is suggested that institutional positions of the enterprises be available to specialized people. In this regard, they must provide the right conditions for the acquisition and maintenance of educated people.

Considering the positive impact of industrialization of provinces on the export performance of industrial enterprises, it is suggested that industrialization should be provided in provinces with potential and actual potential for industrialization, in this case the neighboring impacts of these provinces on the neighboring non-industrial provinces would also be overflowed. This goal can be achieved by studying the status of the provinces and planning the correct region.

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