Simulation and Prediction of Iran's Exports Using the PSO Algorithm to Achieve the Objectives of the Twenty Years Vision Document: A Case Study: Comparison with Turkish Economy

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Abstract
The Vision Document of the Islamic Republic of Iran in the 1404 horizon illustrates a bright future for the country. To achieve the objectives of the Vision Document, there is a need for a quantitative analysis of the indicators discussed in the document. In line with this purpose, the present study was an attempt to simulate, predict and compare economic exports of Iran and Turkey as one of the major macroeconomic indicators using Pso algorithms. Simulation was performed using the bands pattern and the four criteria of mean deviation (MSE), root mean square deviation (RMSE), absolute error percentage (MAPE) and absolute error (MAE). The results indicate that the gap between exports of the two countries has continued since 2000, with the current trend of Turkey's exports doubling the Iranian exports.

Keywords: PSO algorithm, Vision Document, Economic export, Simulation.

Jel Classification: F17, F47, E17

1. Introduction
To achieve growth and development at the macro level in the society, it is essential to have a vision and a plan for the future. In recent years, and in order to have a picture of the future of the country, a concept called the 20-Year Vision Document has entered the literature of economic, social, cultural and political sciences. One of the goals of the vision document is to achieve the first economic, scientific and technological position in the Southwest Asia region (including Central Asia, the Caucasus, the Middle East and neighboring countries). The fundamental question in the context of the 20-year Vision Document is whether it will be possible to achieve the intended goals. The answer to this question requires an efficient tool for predicting the influential variables of the economy. One of the main variables of economic growth is the exports. Regarding exports and the concept of economic growth, it can be stated that with the expansion of the country's international trade relations, export development and the acquisition of foreign exchange resources, the country's

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balance of payments improves, which leads to further growth and development. The most important factors affecting exports are the price of exported goods, GDP, exchange rate and inflation. In order to provide a clear picture of the future of Iran's exports, Turkey has been used as a competitive country in the region in the area intended by the Vision Document. This study aims to predict the future trend of exports in the economy of Iran and Turkey as one of the competing countries in the region until 2025 (1404 AD) using the theoretical foundations of export functions and using the particle swarm optimization algorithm to simulate the exports of Iran and Turkey during the years 2014-1993 based on economic theories and three linear, quadratic and exponential forms. Then, using competitor performance evaluation criteria, it selects the best algorithm and consequential form of the model and uses it to predict the export trend of the Iranian and Turkish economies until 2025.

2. Factors affecting the export of goods and services

The gross domestic product of the exporting country is one of the most important factors whose effect on exports has been confirmed in many of the previous studies. The results of these studies show that higher levels of production are the main reason for export expansion, because surplus production through expansion of exports can enter the international market and increase foreign exchange reserves. Therefore, GDP growth is expected to have a positive effect on countries' exports (Bertil, 1998). Domestic inflation is also one of the variables that can reduce the competitiveness of domestic products in global markets. This effect will be much greater when production inputs are supplied from within (Bond, 1987). There is also much evidence about the relationship between the exchange rate and the amount of exports of goods and services. Exchange rate fluctuations, assuming complete competition, cause adjustments in prices, production and the volume of foreign trade. In this way, as the value of a country's national currency increases, the flow of trade changes to the detriment of that country and the country's share in export markets decreases. One of the important models that is considered in export-related issues, including in estimating export supply and demand models in developing countries, is the bond model. Accordingly, the export function at a given level of aggregate demand and foreign prices is mainly considered as follows:

$$XS_t^R = F(P_R^K, P_X^K, Y_R, E_R)$$

where $〖XS〗_t^R$ is the export rate of commodity K at time t, P_X^K is the export price of commodity K in the world market, Y_R is the production of selected products and E_R is the exchange rate in the free market.

3. Particle swarm optimization algorithm

Due to the existence of different forms for the export function, which are not necessarily linear, as well as predicting the trend of this form, the particle swarm

optimization algorithm has been used to estimate the model. The reason for this choice is the features such as parallel processing, intelligence and flexibility in model identification and predictive behavior of complex systems of ultra-innovative algorithms, which have surpassed classical models. These algorithms provide better results than classical models in pattern recognition, modeling, estimating, identifying and predicting complex and especially nonlinear systems. This algorithm is one of the most efficient methods for optimizing problems. Therefore, it can be used in simulating different models of functions and predicting the future trend of the desired variable.

4. Model estimation results

In this study, the annual data related to exports of goods and services, GDP, effective real exchange rate, inflation rate and price index of exported goods of Iran and Turkey in the period 2019-1993 were used. The data were extracted from the World Development Index (WDI) of the World Bank website, the International Monetary Fund (IMF), the Central Bank of the Islamic Republic of Iran and the Central Bank of Turkey, and MATLAB software was used for optimization of the modeled parameters' value . To simulate the export function based on band theory, three linear, quadratic and exponential forms were examined in the following order:

$$EX_t = a_0 + a_1\,GDP_t + a_2 RER_t + a_3 INF_t + a_4\,PX_t$$
$$EX_t = a_0 + a_1\,GDP_t{}^{a_2} + a_3 RER_t{}^{a_4} + a_5 INF_t{}^{a_6} + a_7 PX_t{}^{a_8}$$
$$EX_t = a_0 + a_1\,GDP_t + a_2 RER_t + a_3 INF_t + a_4\,PX_t + a_5(GDP_t)^2 + a_6\,(RER_t)^2 + a_7\,(INF_t)^2 + a_8\,(PX_t)^2 + a_9\,(GDP_t)(RER_t) + a_{10}\,(GDP_t)(INF_t) + a_{11}(GDP_t)(PX_t) + a_{12}(RER_t)(INF_t) + a_{13}(RER_t)(PX_t) + a_{14}(INF_t)(PX_t)$$

Given that the main purpose of this study was to predict future export values by 2025 (1404 solar), the evaluation of the performance of simulated functions in forecasting exports using the four criteria of standard deviation (MSE), root mean deviation Criteria (RMSE), mean absolute error percentage (MAPE) and mean absolute error (MAE) were performed. These criteria are as follows:

$MSE = \dfrac{\sum_{i=1}^{n}\left(E_i^{observed} - E_i^{simulated}\right)^2}{n}$	$MAE = \dfrac{\sum_{i=1}^{n}\left\lvert E_i^{observed} - E_i^{simulated}\right\rvert}{n}$
$RMSE = \sqrt{\dfrac{\sum_{i=1}^{n}\left(E_i^{observed} - E_i^{simulated}\right)^2}{n}}$	$MAPE = \dfrac{\sum_{i=1}^{n}\left\lvert \dfrac{E_i^{observed} - E_i^{simulated}}{E_i^{observed}}\right\rvert}{n}$

Table 1: Results of model estimation for Iran and Turkey by particle mass optimization algorithm

TURKEY			IRAN			
exponential form	Quadratic form	Linear form	exponential form	Quadratic form	Linear form	
0.0013657	0.4367	0.0051793	0.0016382	1.4768	0.0031256	**MSE**
0.03695	0.6608	0.07196	0.04047	1.21253	0.05590	**RMSE**
0.037433	0.42738	0.069273	0.022788	0.63956	0.031297	**MAE**
0.0012649	0.024103	0.0029364	0.0011326	0.031679	0.0017348	**MAPE**

Source: Research Findings

According to Table 1, for the export function of Iran's economy, among the various simulated sub-forms, the exponential form has shown a more accurate performance in forecasting. For Turkish exports, according to the results presented in Table 2, among the linear forms, the second degree and exponential form of this exponential form has been able to provide the lowest amount of error based on all 4 criteria. Therefore, the function simulated by the PSO algorithm with exponential form was selected for out-of-sample forecasts until 2025 for the export of both countries.
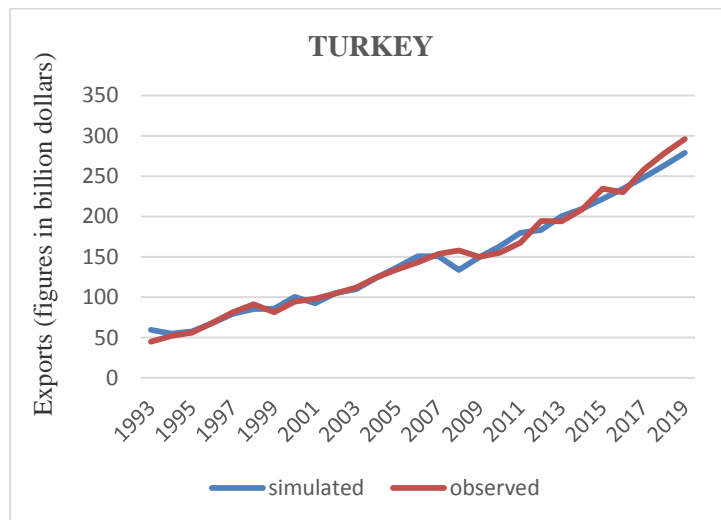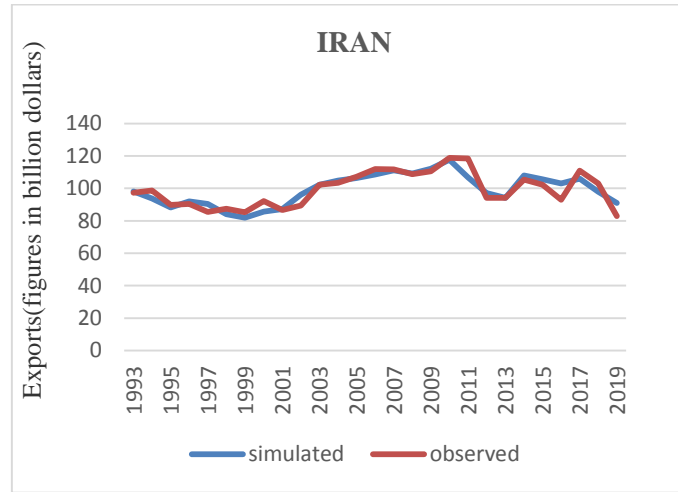

Fig. 1: Mackhed: Research Findings

Fig. 2: Mackhed: Research Findings

To evaluate the robustness of the results, the export values are re-estimated using the simulated model for the years 1993 to 2014 so that the distance between the real export values and the simulated values can be examined to estimate the error rate of the simulated model. The results of this measurement are shown in figures 1 and 2, which are drawn for Iran and Turkey, respectively. As it can be inferred from the graphs, the simulated model has been able to estimate the actual export volumes well over the years.

Now, with confidence in the simulated model, it is possible to predict the amount of exports in the future years for both countries. In order to make out-of-sample forecasts, scenarios should be made about the amounts of GDP and the exchange rate and the index of the exported goods.

Table 3: Export index forecast

YEAR	TURKEY	IRAN
2020	295403711539.70	107035678995.77
2021	313032007121.03	107481248878.41
2022	331770533766.63	107971125201.17
2023	351696114329.80	108504153701.23
2024	372891805568.20	109079306862.21
2025	395447540638.77	109695672195.20

Source: Research Findings (Figures are in Dollars)

As the study of the two countries' export time series in charts 1 and 2 shows, Turkey has surpassed Iran in the export index since 1998. Although in 1999 Iran was able to overcome Turkey again, but finally from 2000 onwards, Turkey has completely ended this superiority and with a higher growth rate than Iran, it has been able to increase this distance every year. According to the results of the

simulated model for the exports of both countries and the forecast for the coming years, if the current trend continues, the gap between the two countries will remain stable and even Turkish exports will be two times as large as the Iranian exports. According to the results of the model in the years under review, Turkish exports with an average growth rate of 7.2 percent is surpassing Iran's exports, which is increasing with an average growth rate of 0.5 percent.

5. Conclusion

In this paper, the particle mass optimization algorithm was used to simulate the export function of the Iranian and Turkish economies for the period 1993-2014. The result of this simulation showed that the particle mass optimization algorithm was able to predict the exports of the Iranian and Turkish economies and among the various forms of the export function, it could more successfully and efficiently predict their export quantities. By simulating the exponential shape of the export function, it was observed that the gap between Turkish and Iranian exports, which has been created since 2000, will continue.

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