The impacts of the novel corona virus on the oil and electricity demand in Iran and China

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Despite significant medical advances in the past centuries, infectious diseases such as the flu or malaria are still a severe threat to society. While some do not have specific geographic areas, others can spread and become epidemic or pandemics. While the first and foremost aspect of an epidemic is the loss of human life and will always remain, the outbreak can also have significant consequences for national or regional economies. The evidence reported in various studies suggests that the epidemic is affecting the country's economy through various aspects, including health, transportation, agriculture, and tourism. At the same time, markets and economic trade with other countries may also be affected, while the convergence of modern economies means that an epidemic can also encompass international supply chains. All these facts state that Coronavirus, as the first major pandemic in the last century, is one of the most critical issues to be studied. These facts, as well as the fast urbanization, increased international travel, and changing conditions are causing a global outbreak, not just a local phenomenon, imply that measures are needed for all countries to tackle this threat. In this paper, the impacts of the Coronavirus on the economic status and Energy demand (mainly oil and electricity) are being studied to determine the vulnerability of the economic and energy security in the time of severing epidemics or pandemics.

keywords: *Coronavirus, Petroleum, Demand analysis, Economic impacts, COVID-19, Pandemic.*

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1. INTRODUCTION

Despite significant medical advances in the past centuries, infectious diseases such as the flu and malaria are still significant threats to modern societies. While some have successfully fought and are only found in a few endemic areas, others can quickly spread from the limited outbreak initially to become an epidemic or pandemic [1].

The first and foremost aspect of an epidemic or pandemic is human suffering and the loss of life and will always remain. However, spreading the virus can also have significant economic consequences. Several studies focusing on this aspect of the impact of epidemics and pandemics have shown that its effects are significant across the economy [2].

A recent paper estimates that the total value of losses (including lost income - through the reduction in labor size and productivity) increases in the absence, and most importantly, as a result of the individual and social actions that drive the transition. Interrupts, but disrupts economic activity. - Moreover, the inherent cost of deaths from the severe global influenza epidemic (such as the 1918 epidemic) can reach about 500 billion USD a year, or about 0.6% of global production [3]. This paper further calculates that the estimated proportion of national annual income shown by these damages varies by income grouping, while low-middle income countries are strongly affected (1.6%). Relative to high-income countries (0.3%). The World Health Organization and World Bank joint report estimate that the impact of such an epidemic is upward, bringing the total cost to 2.2 to 4.8 percent of global GDP (the 3 trillion USD) [4]. The report also notes that in such an event, South Asian GDP could potentially fall by 2% (53 billion USD), and sub-Saharan Africa GDP by 1.7% (28 billion USD). However, another article from the International Monetary Fund found that vulnerable populations, especially the poor, are likely to suffer because they may have less access to health care and less protection in the Facing the financial disaster [5].

At the regional level, a World Bank report estimates that the Ebola epidemic in Guinea, Liberia, and Sierra Leone canceled many of the economic benefits of the past years to those countries that were it could be the fastest-growing economic period in the country [6]. Another WHO report further explains that the outbreak causes a significant growth in the private sector, posing a threat to food security due to reduced agricultural pro-

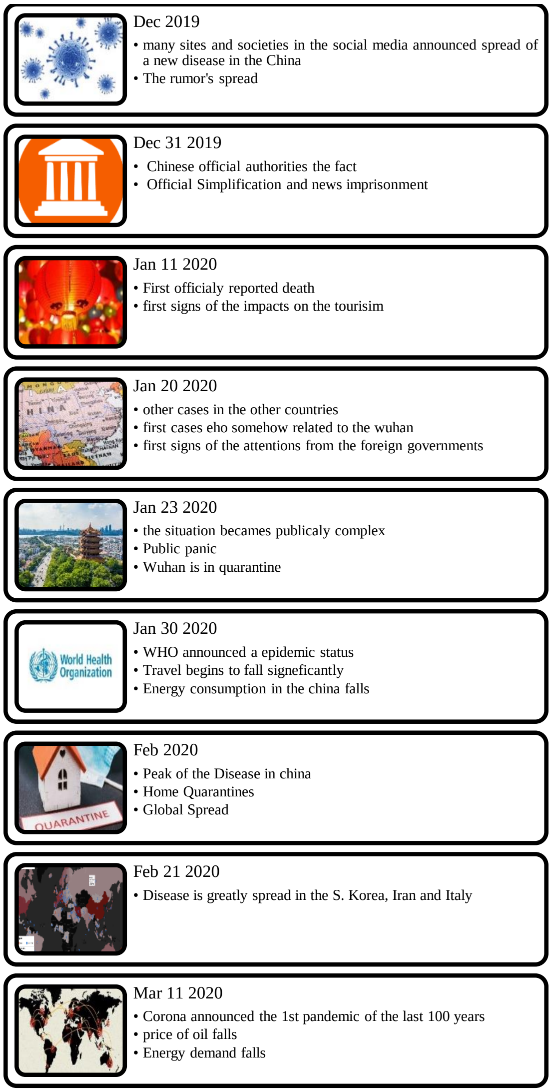

Fig. 1. The timeline of the coronavirus by Dec. 2019 to Mar. 2020.

duction and cross-border trade with restrictions on movement, goods, and services. In particular, while a national or regional economy is always affected by an epidemic, some sectors of the economy are hit harder than others. This paper aims to do quantitative analysis on this issue and determine the importance of each sector and the vulnerability of each with an approach to the petroleum and electricity demand [7]. However, to do this, first of all, a deep cognition from the coronavirus's framework and disease is needed.

Figure 1 shows the timeline of the coronavirus, and this timeline helps to derive a model of the disease's impacts on society.

Figure 2 shows the framework of the coronavirus's timeline, and this figure clearly states that the energy problem in the time of epidemics is much dependent on the social environment. To summarize, it can be said that Although the approach of the issue could be seen as a real energy problem when it is about the epidemics, the other aspects of social and political environments can be useful and affected, too—thus making this problem a real multidisciplinary problem.

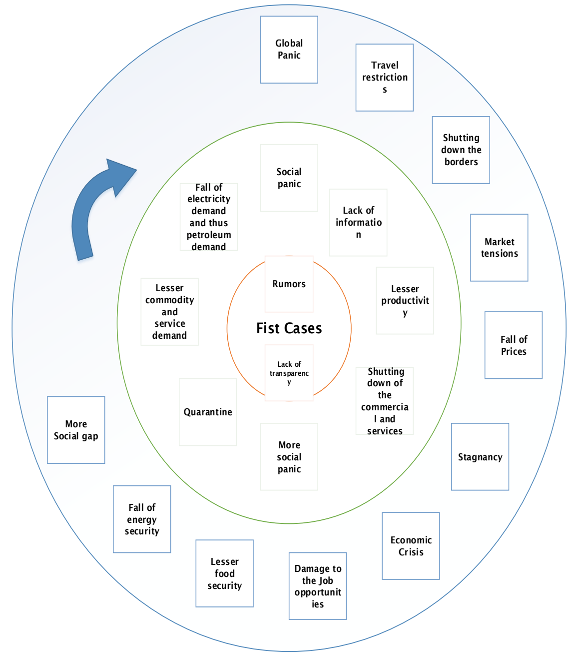

Fig. 2. The trendline model of the disease impact adapted from the coronavirus timeline.

A. Iran's energy sector

As one of the most important members of the Organization of Petroleum Exporting Countries (OPEC), Iran has always played a decisive role in the world energy market. In 2010, Iran was ranked as the third most important exporter of crude oil in the world [1]. Besides, Iran has the world's second-largest natural gas reserves. However, the division of natural gas has not been significantly developed due to inadequate government investment and is mostly used to meet domestic energy demand. In Iran, most of the state budget is always financed by exporting oil revenues. Moreover, the amount of money generated by the export of energy carriers can affect the body of all sectors of the Iranian economy. Historical data show that Iran's total energy consumption increased by 40.2% from 2004 to 2009 [3]. Given that the structure of the Iranian economy is heavily dependent on oil dollars, these statistics show that such an increase in domestic demand is affecting Iran's energy exports, thereby causing Iran to face severe economic problems shortly. To face. Consequently, charting and forecasting the future of domestic energy demand helps government policymakers in the macroeconomic planning process of the energy economy. According to Iran's energy balance report in recent years, the residential sector has usually been a significant segment.

The total amount of electricity demand in Iran. In 2009, 33.03% of electricity was consumed by the sector in the country (55629.6 GWh). Besides, in 2009, 14.02% of crude oil, 57.07% of natural gas, 3.71% of coal, 100% of combustible renewable energy and 51.63% of the country's electricity were consumed by residential and commercial sectors [3]. Given the significant share of electricity demand in this sector, its future estimation will undoubtedly assist the government in policy processes. Keep in mind that a bottom-up approach should be used to achieve more accurate forecasting results in each energy demand segment.

B. Chinese energy sector

First, China's total energy consumption is on the rise. China's total energy consumption increased from 570 Mtce in 1978 to 3250 Mtce in 2010, with average annual growth of 5.6%. In 2010, energy consumption surpassed the United States and ranked first in the world, with energy consumption per capita reaching 2.4%, the world's average. Second, the coal-based energy consumption structure is determined by China's energy supply, although it has begun to move towards clean energy in recent years. Since 2000, the share of coal in total energy consumption has changed slightly, remaining about 70%. Oil fell from 22.2% in 2000 to 16.5% in 2010, while natural gas fell from 2.2% to 4.3%. The scale of electricity, nuclear energy, wind energy, and other non-fossil energy sources has increased significantly, and total non-fossil energy consumption increased from 6.4% in 2000 to 8.3% in 2010. Third, the total energy consumption per unit of GDP is reduced. Significantly, but there is still much room for improvement. From 1978-2009, energy intensity decreased from 3.745 to 1.077 tce per 10,000 yuan, but there is a large gap with the United States, Japan, and other developed countries. Fourth, energy consumption per capita is gradually approaching the global average, but there is a large gap with developed countries. Per capita, energy consumption rose from 0.60 tonnes in 1978 to 2.30 tonnes in 2009, which was very close to the global average (2.34 tce) but below the level of the OECD countries (6.25 tce). Fifth, final energy consumption increased rapidly, but its share of total primary energy consumption decreased. Final energy consumption increased from 480 Mtce in 1980 to 2070 Mtce in 2008, with average annual growth of 5.4%. Its share of primary energy consumption dropped from 79.4 percent in 1980 to 71.1 percent in 2008, largely due to a large amount of coal used for power generation and energy loss.

C. Energy modelling

The first oil crisis of the 1970s began to produce energy models around the world. The first models of power supply were built on only one aspect of the problem. For example, costs, environmental impacts, or energy security. The main models of energy supply only consider one energy segment or even one energy carrier. The first models of energy demand are developed based on econometric methods and theories and link energy demand with some macroeconomic indicators such as GDP. Because these models fail to address the two opposing goals of using low energy carriers and protecting the environment, they do not work well in the face of energy concerns in the nascent world. In recent years, several comprehensive energy models have been developed that address not only all energy consumption and energy carriers but also environmental and energy efficiency trends. These models can be divided into three main categories, including energy demand models, energy supply models, and modular energy models. MEDEE, MAED, and LEAP are the most prominent energy demand models built from the bottom-up approach. EFOM, MARKAL, and MESSAGE are three important models of energy source. They aim to minimize the costs of increasing the capacity of countries in the country, given the technical and financial constraints.

Formulation of Electricity Demand Pattern for Iranian Residential Sector: Based on LEAP demand, the input of these models is power supply. Modular energy models consist of several isolated models that can be used if necessary. These models include macroeconomic indicators, energy supply, and demand balances, and environmental impact models, all collected in one bundle. ENPEP, LEAP, and MESAP models belong to this group.

Energy demand in its various forms, including fossil fuels, plays an essential role in many aspects of society, including economic, social, and political. In this sense, in particular, the modeling and forecasting of energy consumption in general and fossil fuels become more critical. Fossil fuel consumption directly affects phenomena such as air pollution in metropolises. Meanwhile, the energy industry is a complex but essential part of economic growth in any country. Therefore, it is necessary to provide an appropriate model that can predict changes in energy consumption in economic sectors. Different methods and tools are used to analyze energy demand and determine the impact of different factors. Much research has been done to estimate the demand for oil and electricity through linear performance and econometric methods [8]. However, since the variables that affect the demand of the energy carrier are unstable during the time studied, non-linear methods can provide better estimates of energy consumption [9].

Nonlinear phenomena, such as oil consumption and energy consumption, are quite complex and are affected by various factors that have complex behavior. For this reason, modeling through the analysis method of these phenomena is practically impossible. To model such phenomena, traditionally, statistical techniques and regression models have been used, and more recently, artificial intelligence-based methods such as ANN or Regression and other hybrid models. The advantage of using neural networks is their ability to identify and quantify the relationship between input and output variables without the need to obtain a thorough understanding of the physics of the phenomenon [10], and the advantage of simple regression and its results more accurate. It applies to structural relationships.

Numerous studies have reported better performance and fewer errors in neural networks than traditional methods. In this study, a multilayer perceptron neural network with a hidden layer is used to provide a pattern of oil and electricity consumption in Chinese economic sectors. Given the growth of infections worldwide and the challenges of satisfying energy demand, as well as the significant contribution of the oil and electricity sector to the economic status of the countries, analyzing the amount of consumption of oil and electricity in the economic sectors and evaluating the factors that affect it is z issue. It has attracted researchers. Many researchers have predicted and forecast energy demand in China's economic sectors using models with linear, quadratic, and exponential equations based on conventional estimation criteria.

Artificial neural networks are presented as one of the most widely used modeling and prognostic tools and compared with other modeling methods [7, 8]. Authors of [11] predicted Thailand's energy demand in the transport sector through artificial neural networks and non-linear regression models for the next twenty years. The previous research modeled the energy consumption of the transport sector in Jordan and predicted it through the diffuse neural network [12]. The energy demand is that South Korea has been modeled and predicted using artificial neural networks with a structure similar to the method presented in this study [13].

The ability of artificial neural networks to estimate complex nonlinear functions has made them useful tools for complex modeling phenomena. Neural networks, inspired by the nervous system of the organism, can identify patterns and the quantity and type of dependencies between the input and output variables [6]. In recent years, despite the early introduction of neural networks, the use of these tools in various fields of research, commerce, and education has received much attention [7].

In this study, the descriptive variables of the model are broader than previous studies, and the case study is a new novel because the effects of the epidemic on energy have never been studied. This study is the first to investigate the impact of energy consumption on variables such as GDP and the work performance index [9, 10]. In previous case studies on energy demand analysis in China, the data is measured annually. The time frame in this article is more detailed and is recorded and studied monthly. In addition to expanding the data, this can improve the efficiency and regression of the neural network. In addition to the results and purpose of this study, for the first time, Iran and China's energy consumption neural network model is used for sensitivity analysis, which is implemented to estimate the impact of the new coronavirus epidemic on demand for electricity and oil [14] (see Fig. 3).

2. METHODOLOGY

In recent years, the use of integration analysis to estimate energy demand patterns has grown widely. Convergence analysis is commonly used to test short and long term energy demand characteristics. One of the methods of integration analysis that has been widely used in recent years is the distributed distribution approach, which produces irrational estimates of the long-term coefficients. The variables used to model the effect of coronavirus on economic status and energy demand are summarized in Table 1.

In this paper, ordinary least squares, fully fitted least squares, integration analysis, and ARDL methods are used to estimate the energy and energy demand pattern of Iran and China at the time of the outbreak or epidemic. Coagulation tests were performed by the Granger and Johansson-Yuselius tests [13, 14]. The least-squares method is used to estimate the simple pattern of energy demand by Stoke and Watson [15]. Halisiagoglu and Bakertasch also used the two-step Engel-Granger method to model the relationship between energy, economic activity, and price [13].

Sons and Shane and Boys argue that for effective use of this approach, the time series must all be the same, given in Eqs. (1) and (2). The suggested pattern is shown below [16]:

$$\begin{aligned} &\text{LnDemand}_{\text{oil}} = B_1\text{LnGDP} + B_2\text{LnDemand}_{\text{electricity}} + \\ &B_3\text{LnEpidemic} * 10 + B_4\text{LnPopulation}_{\text{infected}} + \\ &B_5\text{LnPMI} + B_6\text{LnExports} + B_7\text{LnFDI} + \\ &B_8\text{LnStocks} + B_9\text{LnP}_{\text{industry}} + B_{10} \end{aligned} \quad (1)$$

$$\begin{aligned} &\text{LnDemand}_{\text{electricity}} = B_1\text{LnDemand}_{\text{oil}} + B_2\text{LnGDP} \\ &B_3\text{LnEpidemic} * 10 + B_4\text{LnPopulation}_{\text{infected}} + \\ &B_5\text{LnPMI} + B_6\text{LnExports} + B_7\text{LnFDI} + \\ &B_8\text{LnStocks} + B_9\text{LnP}_{\text{industry}} + B_{10} \end{aligned} \quad (2)$$

Besides, this vector determines (non-random) variables such as the width of the font, the trend variable, the virtual variables, or the exogenous variables at constant intervals. The number of breaks used for the dependent variable is the number of breaks used for the independent variables. The optimal number of breaks for each of the explanatory variables can be determined using one of the Acaic, Schwartz-Bizin, and Hanan-Quinn criteria. Therefore, the long-term equation for the ARDL model is presented in Table 6 [6].

In recent years, the ARDL approach has been widely used in estimating energy demand. In this approach, energy consumption is explained by its interruption and the current and discontinuous values of independent variables such as price and income. In the traditional ARDL method, when the variables are not variables, a false regression can be obtained unless the variables are cumulative. Even if pattern variables are included, there is concern that standard statistical inference methods are not valid [17]. By modifying the traditional ARDL approach, Boys and Shane demonstrated that even when the model variables are uncontrollable, the standard hypothesis test can be used. In this method, the long and short term coefficients can be estimated below the OLS, and a valid statistical inference can be made using the standard asymptotic distribution theory [18]. The only point necessary to validate them is the existence of a long-term relationship or a coexistence relationship between variables. Therefore, even if the variables are anonymous, the ARDL approach may be valid, provided that the fully modified least squares method (FMOLS) is a semi-parametric approach that is used to estimate individual cohesive relationships with a combination of variables in Eqs. (1) and (2). This method was developed by Phillips and Hansen. Furthermore, Park and Phillips and Hansen and Phillips have shown that this method has advantages that distinguish it from the ordinary least squares method. These include [17, 18]:

- Cloud computing estimates
- Estimates are not biased
- Have normal distribution without signs

It provides a modified standard deviation that allows statistical inference, therefore, the t-test is valid for long-term coefficients.

The structure of neural networks generally consists of several layered neurons with different configurations and communication chains called synapses in the nervous system literature, which provide the connection between neurons. Each synapse has a value in terms of the weight of the synapse that, depending on its weight, transfers the output of one neuron to the input of another neuron [19].

Neural networks have been developed for a wide range of applications and themes. The most common way for artificial neural networks to approximate complicated functions and model phenomena with such behavior is a type of nutritional neural network called an inactive multilayer linear perceptron. This type of neural network is capable of approximating almost any continuous function with arbitrary precision by presenting the number of neurons in the middle layer [20]. The structure of this network consists of an input layer, an output layer, and some hidden layers. Each neuron in each layer connects to all neurons in the next layer, so the output of each neuron is multiplied by the weight of each output synapse attached to it and transferred to the next layer.

Furthermore, at the input of neurons, the received signals are added first. They then enter the neuron firing function and determine its output. In this type of network, non-linear, top-down, and bottom-up performance is used as the trigger function. Since the number of layers has no effect on this network capability and only the middle layer is sufficient, the perceptron neural network with a hidden layer is used in this model.

Table 1. The summary of the variables used in the model

Variable	Sign	N	Unit	Reference	Description
GDP Growth	GDP	425	[%]	World Bank Iranian Central bank	The normalized daily economic growth rate in China and Iran
Oil Demand	Demand_oil	425	Million Barrel	IEA Iranian Central bank	The daily oil demand for china and Iran
electricity Demand	Demand_electricity	425	TWh	IEA Iranian Central bank	The daily oil electricity of China and Iran
Epidemic status	Epidemic	425	-	Author (WHO)	A control index showing severeness of the epidemy
Infected people	Population_infected	425	People	WHO	The daily Cumulative infected people in China and Iran
Manufacturing PMI	PMI	425	-	Trading economics Iranian Central bank	The daily Caixin China General Manufacturing PMI is showing manufacturing productivity in china and Iran
Export income	Exports	425	USD HML	Trading economics Iranian Central bank	The daily export income of china
Foreign direct investment	FDI	425	B USD	World Bank Iranian Central bank	The Cumulative daily foreign direct investment entered in china and Iran
Industrial Productivity	P_industry	425	-	Trading economics Iranian Central bank	Daily industrial Productivity in China and Iran
Stocks value	Stocks	425	-	Shanghai Composite Stock Market Iranian Central bank	The China Shanghai and Tehran?s Composite Stock Market Index

Table 2. Choosing the number of hidden nodes

Number of hidden neurons	Train set error[1] (%)	Test set error (%)
9	15.1	18.1
10	14.9	19.5
11	11	13.4
12	8.7	9.1
13	5.5	6.4

[1] Average Error Percent (APE)

After selecting the appropriate network type for the model in question, neural networks often need to determine their synaptic weights based on the data studied. The process of finding optimal weights for a network is called the "training phase." Typically, some of the available data is used for network training, and the other part is used to test neural network performance. One of the most common methods to train power supply networks is the "Error algorithm" [21].

The initial synaptic weight values are randomly selected from -1 to 1. The hyperbolic tangent is selected for the network activation function. In neural network training, choosing the correct training coefficient for an optimal response is crucial. In MLP neural network training, the training coefficient of different layers can be defined differently. To avoid oscillations of the network around the optimal response, the learning coefficient of the output layer is usually lower than the other layers. This approach is also adopted in this model, and the training coefficient of the last layer is equal to half the coefficient of the hidden layer. The parameters of the artificial neural network are generally adjusted by trial and error [22]. The number of hidden layer neurons due to the complexity of the data was selected by experts practically, and according to the number of cellular responses, the number of neurons increased concerning the network response, as shown in Table 2. The final values selected for the different types of network parameters are shown in Tables 3 and 4. The structure of the selected ANN is shown in Fig. 2.

Using the neural network model, first, through conducting sensitivity analysis on different variables, the amount of the influence and the way they affect the change in the output of the model are investigated. Then, using different scenarios, the amount of oil and electricity demand in the industry and residential sectors of Iran and China will be predicted for the coming months (see Tables 3, 4, and 5).

Changes in the output variable would be observable by modifying the desired input and keeping other input variables constant to determine the output sensitivity toward different input variables. The average ratio of the output changes to the changes in each input has been mentioned (see Fig. 4).

The changes of the output variable have been observed to determine the output sensitivity to different input variables, by applying changes to the desired input and keeping other input variables constant, according to the Eq. (3). The more significant changes of the output variable concerning the changes of the input variable, and the more consistent it is indifferent samples, the more effective the desired variable on the output. Table 3 includes the ratio of the output changes to the changes in different variables.

Table 3. Structural relations between parameters in the neural network model in Iran

print type	X	Y	V4
scale	0	7.2	Bias
scale	0	6.4	Exports_transformed
scale	0	5.6	Stocks_transformed
scale	0	4.8	FDI_transformed
scale	0	4	Ep or PN_transformed
scale	0	3.2	Manufacturing PMI_transformed
scale	0	2.4	Industrial Production_transformed
scale	0	1.6	GDP growth [%]_transformed
scale	0	0.8	infections[person]_transformed
scale	1	7	Bias
scale	1	6	Hidden layer activation: Hyperbolic tangent Output layer activation: Identity
scale	1	5	Hidden layer activation: Hyperbolic tangent Output layer activation: Identity
scale	1	4	Hidden layer activation: Hyperbolic tangent Output layer activation: Identity
scale	1	3	Hidden layer activation: Hyperbolic tangent Output layer activation: Identity
scale	1	2	Hidden layer activation: Hyperbolic tangent Output layer activation: Identity
scale	1	1	Hidden layer activation: Hyperbolic tangent Output layer activation: Identity
scale	2	5.3333	Electricity demand [MW/day]_transformed
scale	2	2.6667	Petroleum Demand [Mlitrs/day]_transformed

$$S_{\omega}^{F} = \frac{\partial F/_{F}}{\partial \omega/\omega} \quad (3)$$

3. RESULTS

A. Results of China

The following table shows the effect of each parameter on the other and the importance of this effect. The information presented in this table is a correlation analysis between the variables of the model.

Table 6 illustrates the importance of the epidemic situation in the economic status of China. According to the model results, the elasticity of each objective parameter to the coronavirus is calculated and reported in Table 7.

Table 6. Pearson Correlation of the parameters for China

	Epidemic	infections	Manufacturing PMI	Exports	FDI	Industrial Productivity	Stocks	GDP growth
Epidemic	1	0.90454	-0.82712	-0.48608	-0.35868	-0.4214	0.06664	-0.85554
infections	0.90454	1	-0.96138	-0.55174	-0.40082	-0.36946	-0.098	-0.96824
Manufacturing PMI	-0.82712	-0.96138	1	0.49588	0.34594	0.34692	0.21462	0.96726
Exports	-0.48608	-0.55174	0.49588	1	0.89866	0.3528	0.0245	0.50862
FDI	-0.35868	-0.40082	0.34594	0.89866	1	0.147	-0.10976	0.34594
Industrial productivity	-0.4214	-0.36946	0.34692	0.3528	0.147	1	0.47432	0.32928
Stocks	0.06664	-0.098	0.21462	0.0245	-0.10976	0.47432	1	0.15778
GDP growth	-0.85554	-0.96824	0.96726	0.50862	0.34594	0.32928	0.15778	1

Table 4. Structural relations between parameters in the neural network model in China

print type	X	Y	V4
scale	0	7.2	Bias
scale	0	6.4	FDI_transformed
scale	0	5.6	Exports_transformed
scale	0	4.8	Ep or PN_transformed
scale	0	4	infections_transformed
scale	0	3.2	Manufacturing PMI_transformed
scale	0	2.4	Industrial Production_transformed
scale	0	1.6	Stocks_transformed
scale	0	0.8	GDP growth_transformed
scale	1	6.8571	Bias
scale	1	5.7143	Hidden layer activation: Hyperbolic tangent Output layer activation: Identity
scale	1	4.5714	Hidden layer activation: Hyperbolic tangent Output layer activation: Identity
scale	1	3.4286	Hidden layer activation: Hyperbolic tangent Output layer activation: Identity
scale	1	2.2857	Hidden layer activation: Hyperbolic tangent Output layer activation: Identity
scale	1	1.1429	Hidden layer activation: Hyperbolic tangent Output layer activation: Identity
scale	2	5.3333	Electricity demand_transformed
scale	2	2.6667	Oil Demand_transformed

Table 5. The best selected ANN specifications

Training rate	0.0075
The momentum coefficient	0.5
The number of hidden neurons	13
Activation Function	Hyperbolic Tangent

Table 7. The elasticity of each parameter to the coronavirus epidemic severeness and the population of infected for China

	Population elasticity	Severeness elasticity	t-parameter	Sig.
Industrial productivity	-5.929	-10.4566	-9.6726	0
Stocks	-0.1764	-0.6566	-9.9834	0
GDP growth	-1.0976	-0.4312	-21.11508	0
Electricity demand	-0.637	-0.098	-2.18736	0.0392
Petroleum demand	-0.098	-0.882	-6.6346	0

Table 7 shows that the new Coronavirus has a significant impact on the economic and energy demand in China and possibly in other parts of the world (if the region is contaminated). The results show that industrial productivity decreases due to disease, but its severity is significant due to social panic, and a 10% increase in its severity index causes a 10.45% decrease in the productivity index. The term severeness index is also the most crucial factor in the stock value index, which causes a 0.656% reduction in the value of the stock. Gross domestic product is also exposed to infected people, with a 10 percent increase in the infected population, the GDP growth rate experiences a 1.1% reduction. If the infected population increases by 10%, the demand for electricity will also decrease by 0.637%. However, oil demand is more reliant on the stocks and the social and political status of the global markets, which is experiencing a 0.882 percent decline due to a 10 percent rise in the severeness index. Table A1 shows the indirect impact of Corvirus on other economic parameters by influencing the most important parameters that have the most significant effect on them.

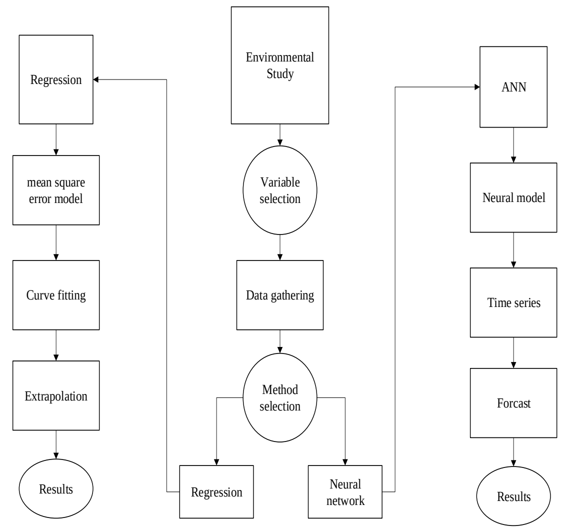

Fig. 3. The schematics of the research process.

Figure 5 shows the effect of each model parameter on the other parameters. The elasticity coefficient of each parameter indicates the other parameters, and this figure clearly shows the direct and indirect impact of the Coronavirus on energy demand, especially the consumption of oil and electricity in China. The model output is plotted according to the actual output model data in Fig. 6.

B. Results of Iran

The following table shows the effect of each parameter on the other and the importance of this effect. The information presented in this table is a correlation analysis between the variables of the model.

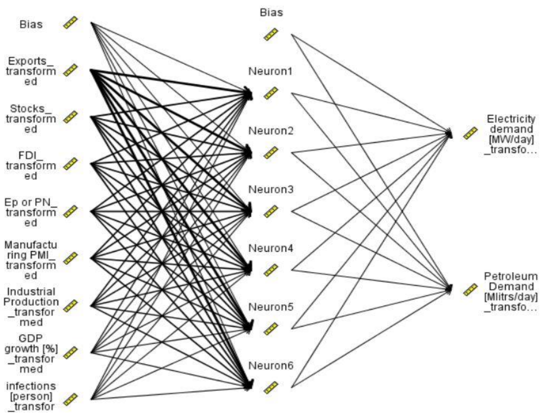

Fig. 4. The structure of selected ANN.

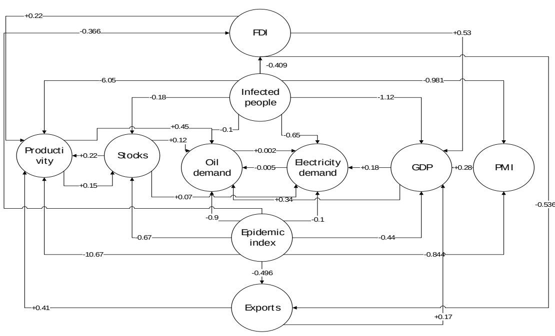

Fig. 5. The co-integrated relation between the model parameters and the elasticity of each parameter on the others (Pro.>95%) for China.

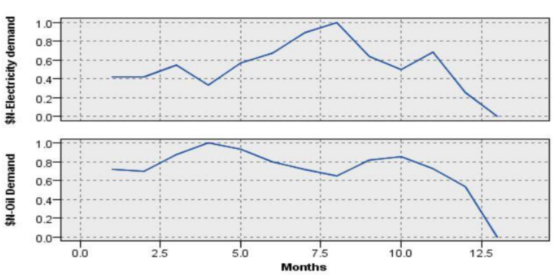

Fig. 6. The output of the model for the data for China.

Table 8 shows the importance of the epidemic in the different aspects of the economy of Iran. According to the model results, the elasticity of each objective parameter to the coronavirus is calculated and reported in Table 9 for Iran.

Table 9 shows that the new Coronavirus has a significant impact on the economic and energy demand in Iran. The results show that industrial productivity decreases due to disease, but its severity lesser than china because of the small share of the industrial sector in the economic productivity and higher dependency of the country to the imports. The term stock index is also one of the essential factors in the economic status of each country, but the Epidemic infection seems not to be effective in the stock market and its value (sig.>0.05). Gross domestic product is also exposed to infected people, with an elasticity of -0.993% per 10%

Table 9. The elasticity of each parameter to the coronavirus epidemic severeness and the population of infected for Iran

	Population elasticity	Severeness elasticity	t-parameter	Sig.
Industrial productivity	-0.337	-0.435	-9.7522	0
Stocks	0.483	0.725	1.00098	0.23
GDP growth	-0.993	-0.926	-23.18542	0
Electricity demand	-0.357	-0.42	-2.3416	0.0366
Petroleum demand	-0.487	-0.593	-7.33926	0

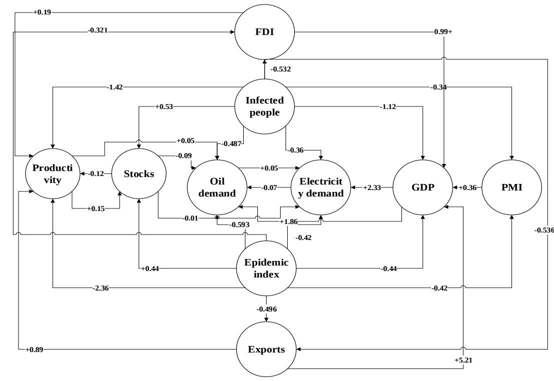

Fig. 7. The co-integrated relation between the model parameters and the elasticity of each parameter on the others (Pro.>95%) for Iran.

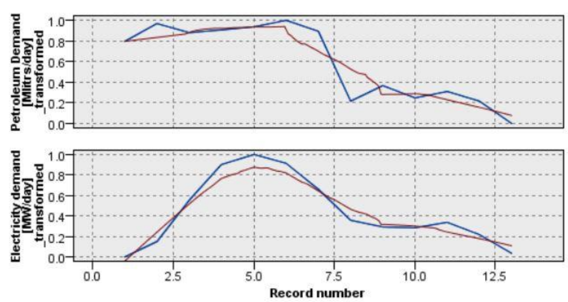

Fig. 8. The output of the model for the data for Iran.

increase in infected people population. Furthermore, the outputs of the model show that if the infected population increase by about 10% of the petroleum and electricity demand of Iran reduces over 0.48 and 0.35%, respectively. Table A2 shows the indirect impact of Corvirus on other economic parameters by influencing the most important parameters that have the most significant effect on them.

Figure 7 shows the effect of each model parameter on the other parameters in the Iranian economic structure. The elasticity coefficient of each parameter indicates the other parameters, and this figure clearly shows the direct and indirect impact of the Coronavirus on energy demand, especially the consumption of oil and electricity in Iran. The model output is plotted according to the actual output model data in Fig. 8.

C. Discussion and comparison

The reduction is equivalent to the energy of about 30 million tonnes of thermal coal or about nine million tonnes of liquefied

Table 8. The elasticity of each parameter to the coronavirus epidemic severeness and the population of infected for China

	Epidemic	infections	Manufacturing PMI	Exports	FDI	Industrial productivity	Stocks	GDP growth
Epidemic	1	0.888	-0.42	-0.593	-0.875	-0.464	-0.302	-0.435
infections	0.888	1	-0.357	-0.487	-0.995	-0.344	-0.218	-0.337
Manufacturing PMI	-0.42	-0.357	1	0.604	0.323	0.75	-0.082	0.235
Exports	-0.593	-0.487	0.604	1	0.462	0.74	0.551	0.356
FDI	-0.875	-0.995	0.323	0.462	1	0.303	0.181	0.354
Industrial productivity	-0.464	-0.344	0.75	0.74	0.303	1	0.304	0.156
Stocks	-0.302	-0.218	-0.082	0.551	0.181	0.304	1	0.226
GDP growth	-0.435	-0.337	0.235	0.356	0.354	0.156	0.226	1

natural gas (LNG). China has sought to prevent the spread of the viral epidemy that has killed more than 1,400 and more than 60,000 people by extending the New Year's holidays for another week (Oct. 26th, 2019 to Jan. 7th, 2020) and encouraging people to work from home. Last year, industrial users consumed 4.85 trillion kWh, accounting for 67% of the country's productivity. Shizhou Zhou, global head of energy and renewables at IHS, said if the epidemic persists beyond March 2020, China's economic growth rate could drop to 4.2% by 2020, from the company's initial forecast of 5.8%. While power consumption will only climb. 3.1 percent, compared to the initial forecast of 4.1 percent. "The main uncertainty is still under the speed of the virus spread," Zhou said, noting that the impact on the electricity sector will be relatively moderate by 2020. In Hubei province, the virus-carrying center, the peak load - measuring power consumption - was 21 percent lower than planned by the end of January, data from Wood Mackenzie Energy Consulting showed. Industrial productivity rates point to a significant decline in electricity consumption in China. Plastic processors work between 30% and 60% of their full potential, and according to another research study by ICIS China, the low level will last for another two months by April 2020. ICIS data showed that knitting machines work in textile factories below 10 percent capacity, the lowest in five years. China is the world's largest exporter of textiles and clothing (see Figs. 9 and 10).

According to people with domestic knowledge of the country's energy industry, Chinese oil demand has fallen by about 3 million barrels a day, or 20% of total consumption, as the Coronavirus is pushing the economy. This fall is probably the most significant demand shock the oil market has suffered since the global financial crisis of 2008-2009 and the most sudden Sept. 11th, 2001 crisis. This could force the hands of OPEC and its allies, who are considering an emergency meeting, to cut production and reduce prices in the time of epidemics (see Figs. 11 and 12).

The World Bank data shows that the coronavirus damaged the Chinese economy severely in the last three months. Moreover, this caused about 1000 billion USD damage to the overall economy (-1.7% monthly Growth rate). Moreover, in Iran, economic productivity will lose weight in a sharper trend of -5.8%, which may cause more than 40 billion USD damage to Iran's economy (see Figs. 13 and 14).

Considering the changes in the input in the future, the output will be obtained for different scenarios, and the petroleum and electricity demand for the coming months in China and Iran will be forecasted. Two scenarios for the processes of changes in the input variables in the future are considered, and the predictions are made based on them to do this.

The first scenario is formulated based on the disease being

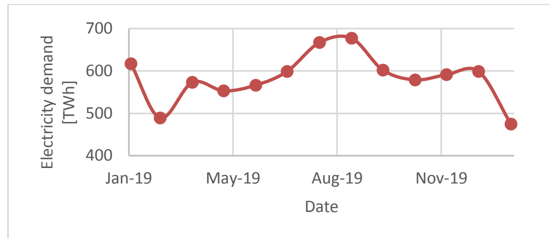

Fig. 9. Mean monthly Electricity demand in TWh of China.

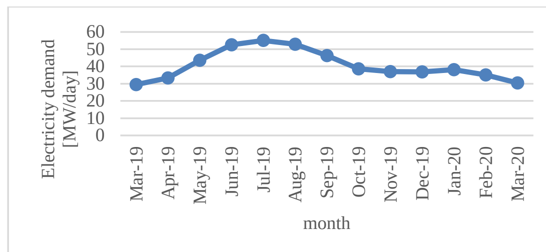

Fig. 10. Mean monthly Electricity demand in Iran.

controlled. Assumptions of the first scenario:

- The infected population growth is considered to be equal to 0.005%/week
- The FDI grows 2.5%/week
- The Stocks return to the stability of the Pre-epidemic era
- Exports grow 4%/week

In the second scenario, a state is examined that the infection cannot be controlled. Assumptions of the second scenario:

- The infected population growth is considered to be equal to 2%/week
- The FDI decreases by 1.2%/week
- The Stocks stays instable
- Exports reduce 1%/week

The results of applying these three scenarios are presented in Figs. 15-18.

Considering the results shown in Tables 10 and 11, Iranian Gross domestic product (Size of the Economy) will be more vulnerable toward the Corona Virus comparing to the Chinese economic status (-0.993/-1.097, -0.926/-0.431). The results show that Iranian markets are more dependent on the Psychological atmosphere of society. As mentioned before, the stocks market in Iran is not Determine using economic productivity, and it is a Theatrical and unrealistic financial index that is used as a

Table 10. Comparing the epidemic's impacts on the Iranian and Chinese economic and energy status in the term of elasticities

	Iran		China	
	Population elasticity	Severeness elasticity	Population elasticity	Severeness elasticity
Industrial productivity	-0.337	-0.435	-5.929	-10.4566
Stocks	NAN	NAN	-0.1764	-0.6566
GDP growth	-0.993	-0.926	-1.0976	-0.4312
Electricity demand	-0.357	-0.42	-0.637	-0.098
Petroleum demand	-0.487	-0.593	-0.098	-0.882

Table 11. Comparing the epidemic's impacts on the Iranian and Chinese economic and energy status in the term of sensitivity analysis

	Iran		China	
	Population sensitivity	Severeness sensitivity	Population sensitivity	Severeness sensitivity
Industrial productivity	-0.43562	-0.479164	-6.78934	-12.45531
Stocks	NAN	NAN	-0.81186	-0.89298
GDP growth	-0.95041	-1.04544	-0.88321	-0.27913
Electricity demand	-0.37628	-0.41382	-0.88622	-0.66382
Petroleum demand	-0.35644	-0.39204	-0.3564	-0.77204

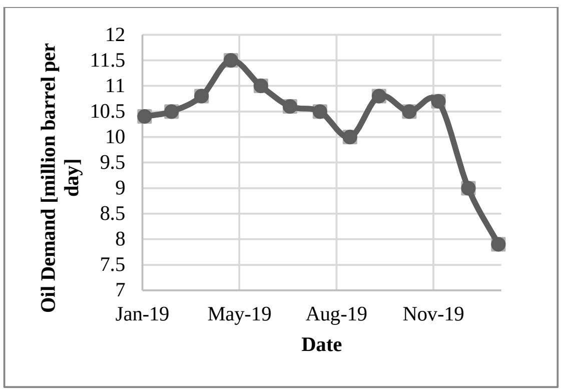

Fig. 11. Mean monthly oil demand in Million barrel per day in China.

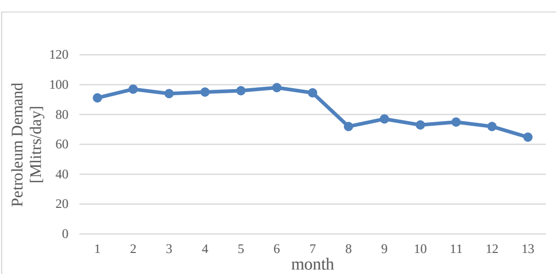

Fig. 12. Mean monthly oil demand in Million liters per day for Iran.

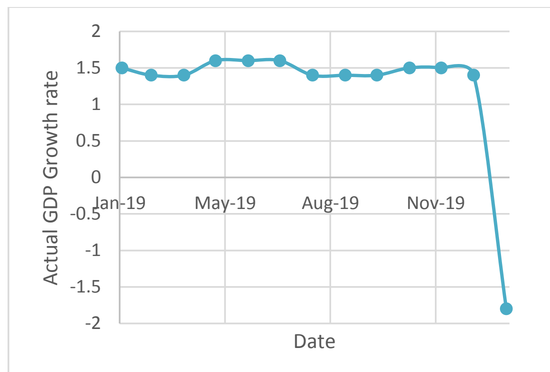

Fig. 13. Mean monthly GDP Growth rate in China.

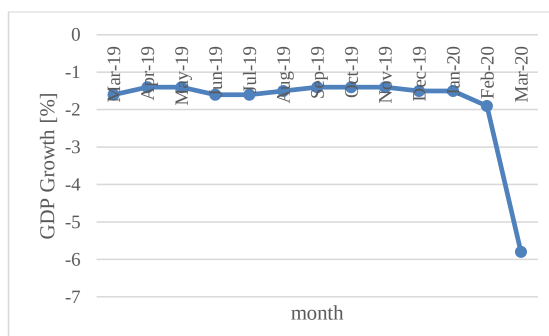

Fig. 14. Mean monthly GDP Growth rate in Iran.

monetary device by the Iranian central bank to control inflation. In China stocks market is damaged by the epidemic status, and the results show that the panic in the stocks holders and also the PMI and Productivity indexes are the most essential and useful factors in the value of the Chinese stock. The damage to the productivity index is small in Iran comparing to that of China, because of the weaker industries and overall productivity in Iran comparing to the P.R.C. Electricity demand also shows that Iranian demand behavior is not affected as high as it is affected by the epidemic in China. Moreover, the petroleum demand is not reduced as much as Chinese demand because of the different governmental policies of the Iranian officials, which encourage people to increase their gasoline and other oil derivatives to compensate for the budget deficit caused by the U.S sanctions.

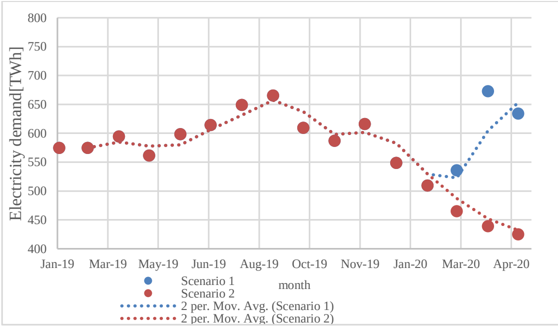

Fig. 15. Electricity demand forecast based on the model output with the assumptions of the first and second scenario in China.

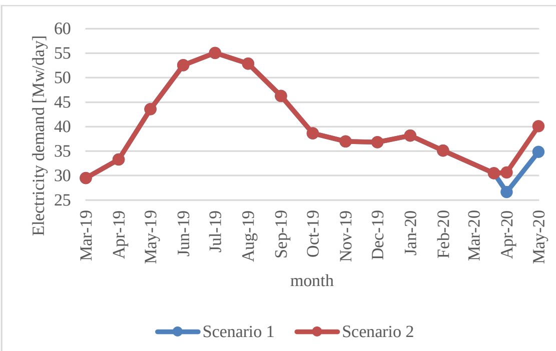

Fig. 16. Electricity demand forecast based on the model output with the assumptions of the first and second scenario in Iran.

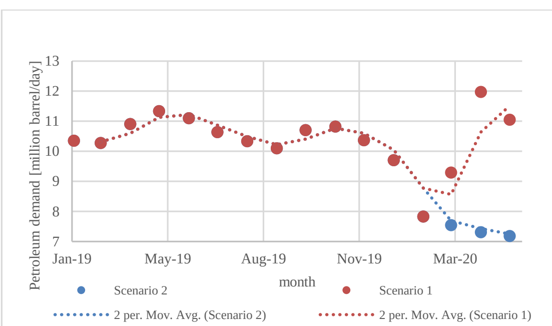

Fig. 17. Petroleum demand forecast based on the model output with the assumptions of the first and second scenario in China.

4. CONCLUSION

Currently, the novel Coronavirus epidemic is underway, preventing a comprehensive study of its impact. As Commissioner Gentilonius pointed out on February 26, 2020, while China's weight gain in the world economy since the outbreak of SARS in 2003 has undoubtedly had an impact, it is too early to assess this and provide a comprehensive study forecasts for the China and its impacts on the other regions like EU or Australia. However, given China's containment measures and preventive measures taken by the rest of the world, the first attempt has been made

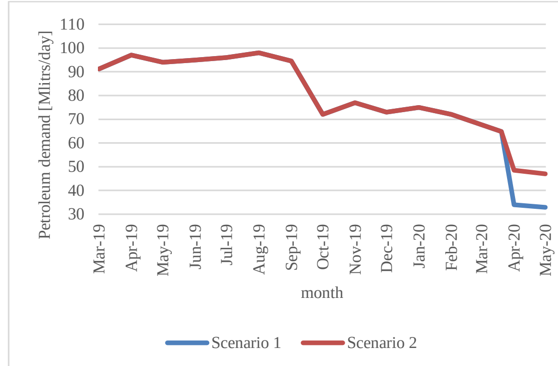

Fig. 18. Petroleum demand forecast based on the model output with the assumptions of the first and second scenario in Iran.

to estimate the likely impact on the economy. As noted, the first visible impact on the health sector has not been the most significant number of patients or potential patients, which has expanded the capacity of many hospitals in Wuhan and the surrounding provinces and prompted officials to build other hospitals quickly [20]. Another major impact is expected to be the significant impact of travel disruption during the Chinese New Year (when much Chinese return home for the holidays), as well as containment measures around several Chinese cities, which are expected to hit significantly [21]. The outbreak is also expected to suffer even more than during the SARS epidemic, with seizures increasing significantly [22]. Therefore, with the support of Chinese authorities, these downward factors are expected to push China's growth, reflecting a downward trend that began several years ago. However, the damage will not be limited to China [23]. Indeed, given that Wuhan - the center of the crisis - is also one of the largest transport hubs in the country, the impact is expected to extend to national and international airlines. Also, global tour operators are expected to harm the world, as many countries issue travel alerts for popular tourist destinations. Countries whose economies are dependent on tourism (e.g., Greece, France, or Italy) are currently adjusting their forecasts [24]. Many international technology companies or component providers for such companies (e.g., Apple or Samsung) have plants in damaged Chinese provinces, and the virus, along with preventive measures, damages international supply chains [25]. According to S&P rating agency assumptions and estimates, COVID-19 could reduce the GDP growth rate of Wuhan by 20%, for the world by 0.3% (ppt), for China with a total rate of 0.7 percent, for the Asia and the Pacific 0.5 percent; and for the United States and Europe with 0.1 to 0.2 percent [26]. Abroad Depending on how prevalent it is in northern Italy, there is a risk that supply chains will collapse for several car manufacturers, including Fiat, Renault, or BMW [27]. Also, the fact that the Lombardy, Veneto, and Milan areas have been affected by this outbreak - and this part of the response includes the closure of schools, offices and tourist attractions - is expected to affect the Italian economy at a critical time [28]. Likewise, the virus shocks oil demand: In recent years, China has grown to account for about 50% of world oil demand, so when demand in the country declined by 20-25% due to quarantine measures. Oil prices were damaged significantly, and also the infections in the middle eastern countries can damage oil supply significantly due to the lesser productivity as it was mentioned before since the crisis is not ended yet. There is not enough data; it is hard to study the crisis comprehensively. However, there are Some recommendations which can be made for epidemic conditions [29]:

1. OPEC shall decrease its oil supply to maintain the petroleum price in a feasible status during the time of epidemics like coronavirus.
2. Countries should have restricted the health control on the import and export goods
3. Smart grids are to be implemented to control the severity of the epidemic disease condition
4. Global cooperation needs to be installed for the time of epidemics to hasten the management of the issue.

APPENDIX

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Table A1. Indirect impacts of the Coronavirus in the term of the parameters mentioned in Table 7 for China

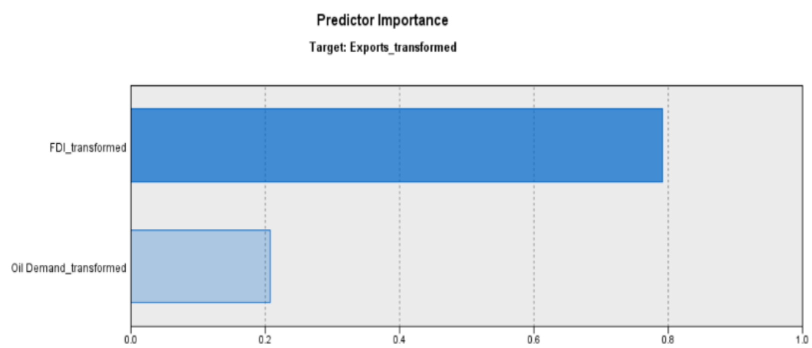
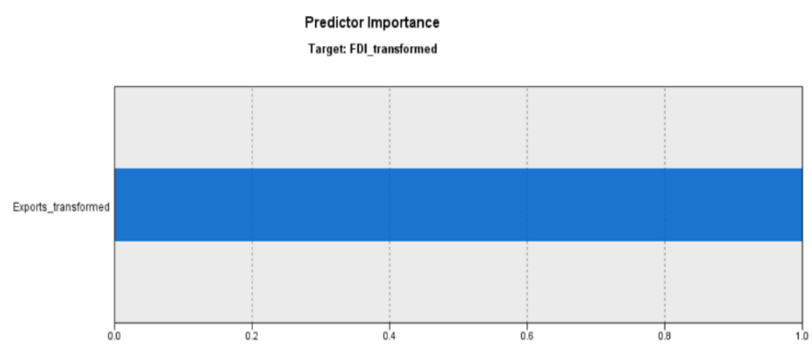
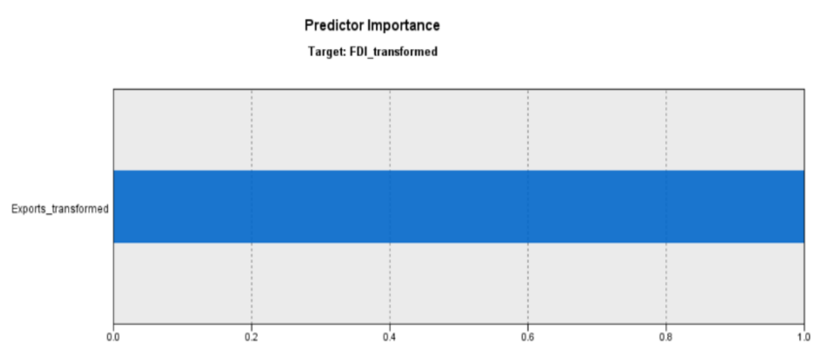
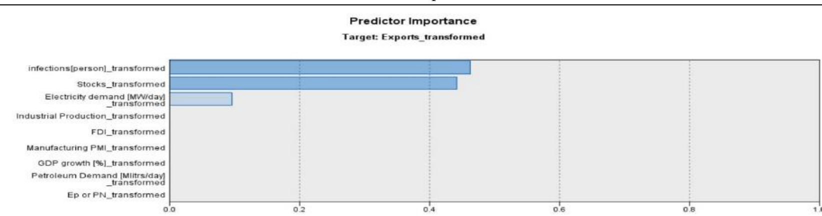
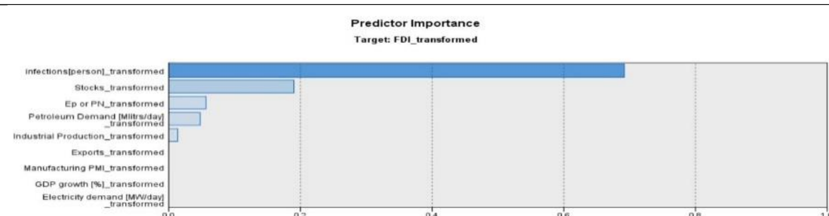
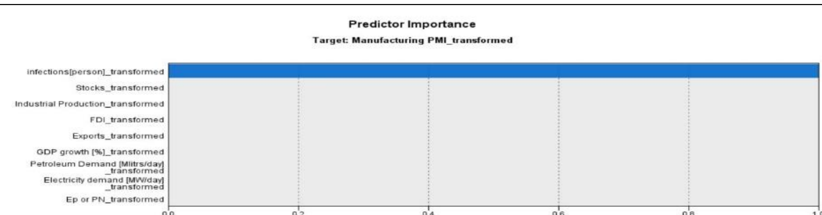
Indirectly affected parameter	Predictor importance	Driving forces affected by the virus
Export income		FDI and Oil demand
Foreign direct investment		Export income
PMI manufacturing index		Export income

Table A2. Indirect impacts of the Coronavirus in the term of the parameters mentioned in Table 9 for Iran

Indirectly affected parameter	Predictor importance	Driving forces affected by the virus
Export income		FDI and Oil demand
Foreign direct investment		Export income
PMI manufacturing index		Export income