COMPARISON INFLUENCES OF VARIOUS ECONOMIC INDICATORS DUE TO DIFFERENT METHODS OF MODELING AND SIMULATION

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ABSTRACT
The present paper shows the results of research that aims to compare simulation results influences of gross domestic product and logistic elements made using artificial neural networks and the results of a simple graphical modeling of the same influences. Artificial neural network simulation results are part of a previous paper of the same authors, while the graphical modelling makes the subject of the present work. The modeling is done by determining graphs based on getting approximate influence functions between the following indicators: transportation and storage, trade balance, international trade in services, annual percentage change in total employed population over the gross domestic product. Data contained values recorded in the Netherlands during 2004-2014 period.
While in the case of simulation with artificial neural networks have determined that the international trade in services have influences the gross domestic product with a ratio equal to the sum of all other indices, graphical modeling led to other models of influence or evolution of indices values.
The authors believe in the need of the use of the new simulation and modeling models and new influences functions between various economic indicators

KEYWORDS: *modelling, GDP, mathematical function, graphic.*

JEL CLASSIFICATION: *C45*

1. INTRODUCTION

The ability to predict economic indicators influenced from a few economic activities is very appealing. Many risks, economic errors and financial crises of different sizes can be avoided or their negative effects can be minimized if they can be forecasted.
But seeing them generally involve complicated mathematical functions involving a large number of variables that cannot react with the same value change when sudden changes in size of economic indicators due to economic crises.
It would be advantageous and efficiently that one can predict the value of gross domestic product of a country based on some values that characterize logistics activity to that country. For examples one can chose can choose results of economic activities like transport or trade services or other indicators such as number of employees. Also must be determined and used a method that can provide conclusive, viable and reliable results for this kind of problem if possible lowering the limitations of classical mathematical functions.

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Therefore the aim of this paper is comparing two different methods used to predict trends data: simulation using neural networks and graphical analysis method.

2. METHOD

The method consists in comparing the results of the two methods of evaluation of influence quantities of four economic indicators on GDP.
The first method - simulation using artificial neural networks - was the object of other research and other works and will use its results for the present paper. The second method consists in the graphical representation of GDP depending on the individual economic indicators to determine trends (functions and graphics) and finally graphical representation of response surfaces for comparison the amount of influence on GDP. Graphical representation method with calculation functions and graphs is suitable especially for the lack of clear influence between different data determined mathematically.
Functions are used to determine trends influence between different data using different types of functions they are determined to approximate their more accurate forms for the influence graphs.

3. RESEARCH

The data used are measured between 2004 and 2014 and represents statistical data of Netherlands and are the following:
Input data:

- ***Transportation and storage - Production value – TAS*** – Annual detailed enterprise statistics for services
- ***Trade balance [in mill. ECU/EURO] – TBA***
- ***International trade in services [Net balance at current prices (in % of GDP)] – ITS***
- ***Annual percentage change in total employed population [%] – APE*** – all persons who worked at least one hour for pay or profit during the reference week or were temporarily absent from such work, as presented by European Eurostat website.

Output data:
Gross domestic product at market prices [mill. Euro] – GDP – defined by the European Eurostat website is the final result of the production activity of resident producer units.
As you can see these data can be found in the position to directly or indirectly influence each other but there is not a mathematical function to calculate and accurately represent influences. The authors studied the simulation of influence of input (TAS, TBA, ITS, APE) on output data seeking to determine a way to be able to predict by simply reading the data input and using a trained ANN to determine the future values of GDP.
In order to perform the approximation of functions and the graphical representations Mathcad 14 software was used and a laptop configuration was:

- ACER 16
- Processor: Intel® Core™ i5-4210M CPU @ 2.60Hz
- Installed memory: 3.98 GB
- System type: 64-bit Operating System, x64 based processor
- Operating System: Windows 8.1 Pro

3.1 Data

Data values used in research were registered against the European Union's Eurostat website and presented in Table 1 as initial data.

Table 1. Initial data values

Year	IN				OUT
	TAS	TBA	ITS	APE	GDP
2004		30,347	0.7	-1.2	523939.00
2005	58,320.0	34,201	1.1	0.7	545609.00
2006	64,326.3	37,271	1.4	2.2	579212.00
2007	69,275.7	42,458	1.6	2.9	613280.00
2008	72,406.7	38,742	1.5	1.6	639163.00
2009	63,574.4	39,244	1.0	-0.9	617540.00
2010	66,717.5	43,632	1.4	-0.7	631512.00
2011	71,424.2	48,898	1.5	0.9	642929.00
2012	73,283.0	53,274	1.3	-0.2	645164.00
2013	74,041.0	61,592	2.3	-0.9	650857.00
2014	74,500.0	63,635	2.2	-0.2	662770.00

Source: adapted from European Eurostat website http://ec.europa.eu/eurostat

3.2 Data influences as simulated by Artificial Neural Networks

ANN's determination of the inputs with the most important influences on the output are shown in figure 1 and table 2. The most influential in training process is ITS, while the smallest influence has TAS.

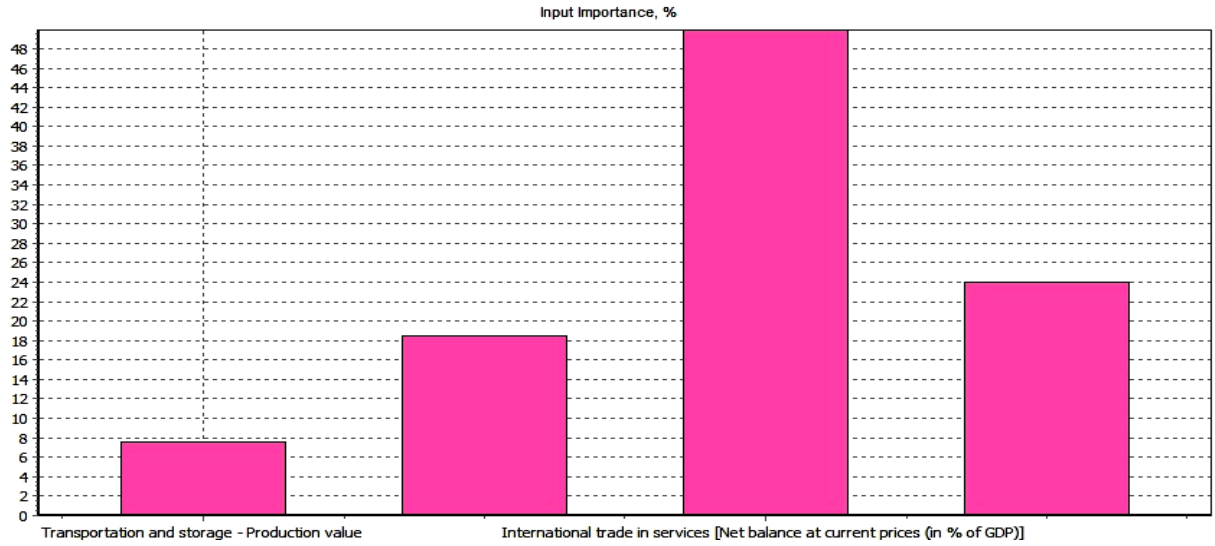


Figure 1. Input importance for the training results [%].
Source: Our own simulation with Alyuda NeuroIntelligence

Table 2. Column importance.

Input column name	Importance, %
Transportation and storage - Production value	7.590.857
Trade balance [in mill. ECU/EURO]	18.489.606
International trade in services [Net balance at current prices (in % of GDP)]	49.917.075
Annual percentage change in total employed population	24.002.462

Source: Our own simulation results.

3.3 Data influences as represented in graphs

In order to determine the function the authors used Mathcad software and built an algorithm to determine trends based on actual data values and considered their graphic representation.

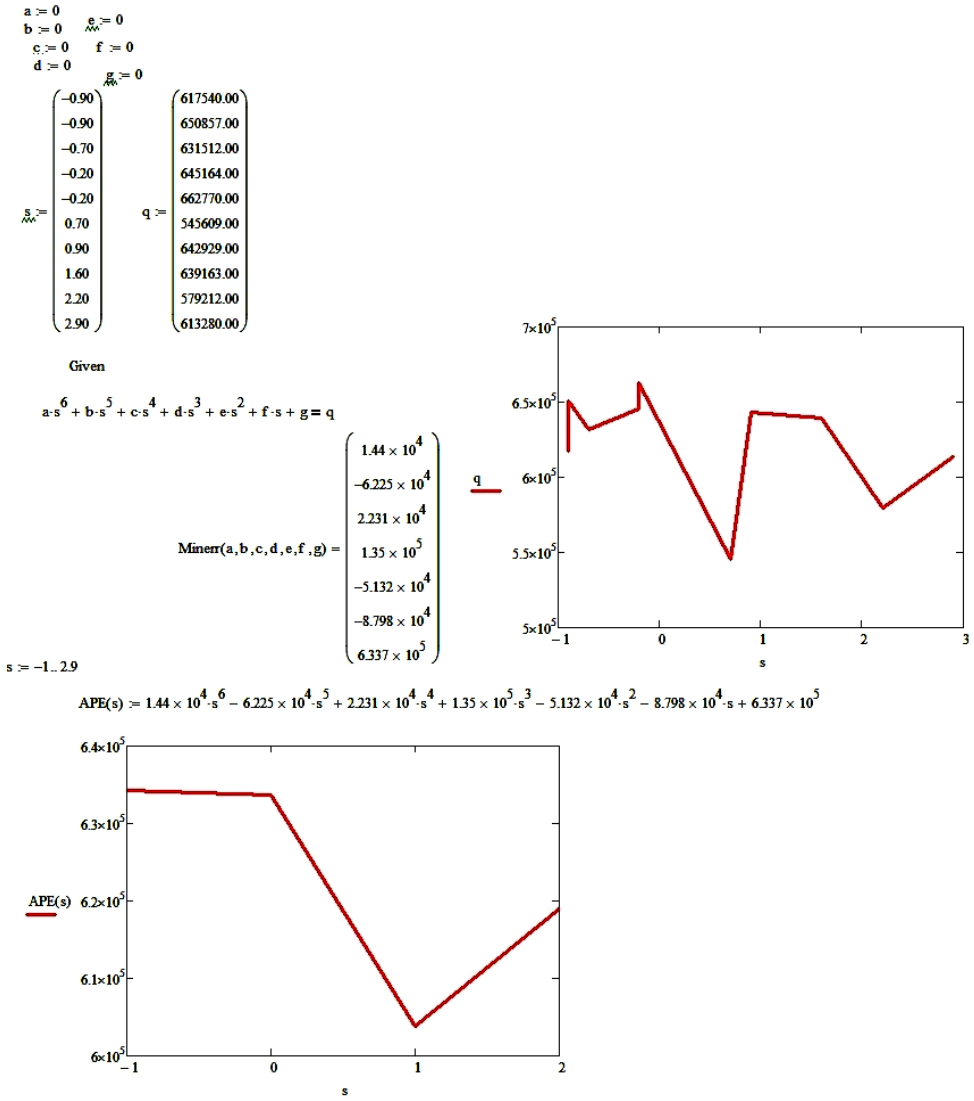
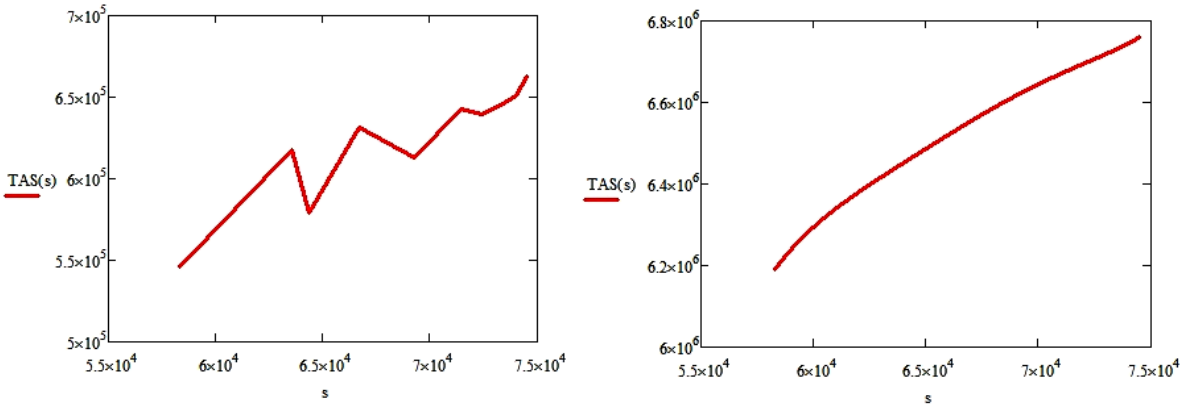


Figure 2. Example of the function determination using Mathcad software for APE - Annual percentage change in total employed population [%].

Source: Our own simulation with Mathcad 14.

As you can see in Figure 2, the model chosen by the authors for the trend is the type polygon function with maximum six. After determining that governs functions trends, these were used to develop graphs trends. Graphs trends graphs are then compared with the initial observation forms coarse possible errors.

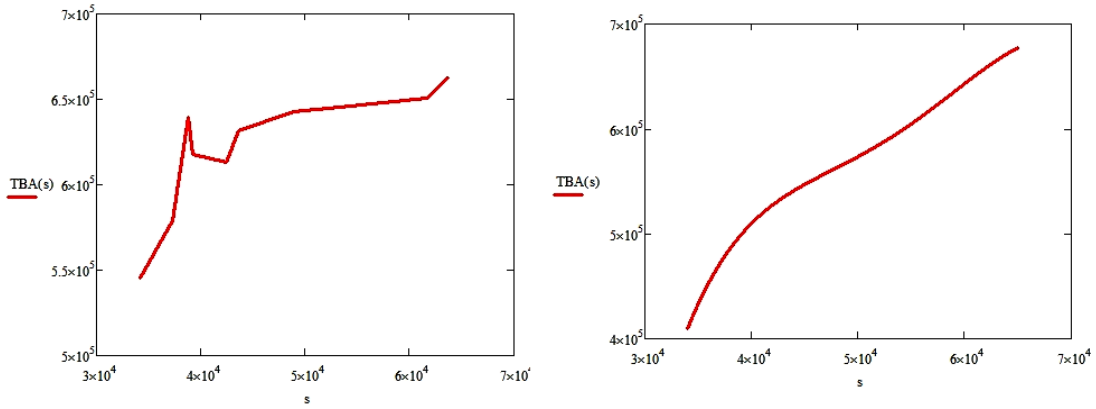
In Figures 3 to 6 presents the evolution of GDP according to each data (a), also the graphic representations of trends for the same data pairs are represented (b).



a) **b)**

Figure 3. TAS evolution: a) real data; b) trend representation.

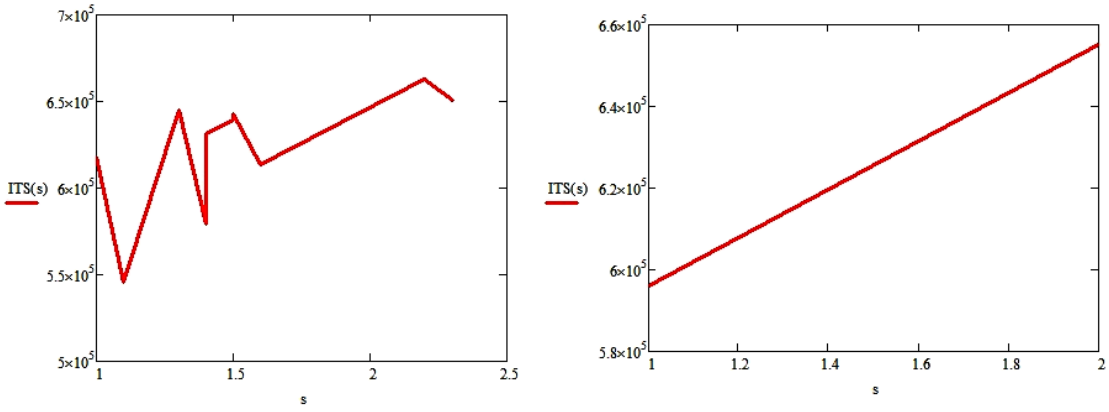
Source: Our own simulation with Mathcad 14.



a) **b)**

Figure 4. TBA evolution: a) real data; b) trend representation.

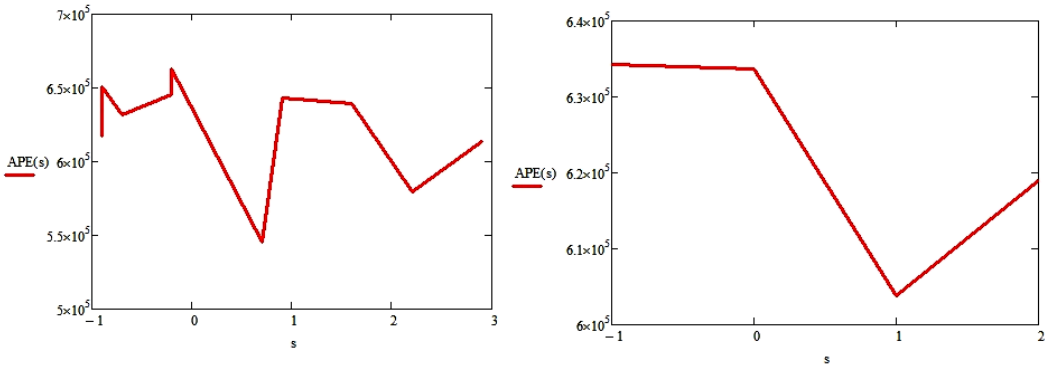
Source: Our own simulation with Mathcad 14.



a) **b)**

Figure 5. ITS evolution: a) real data; b) trend representation.

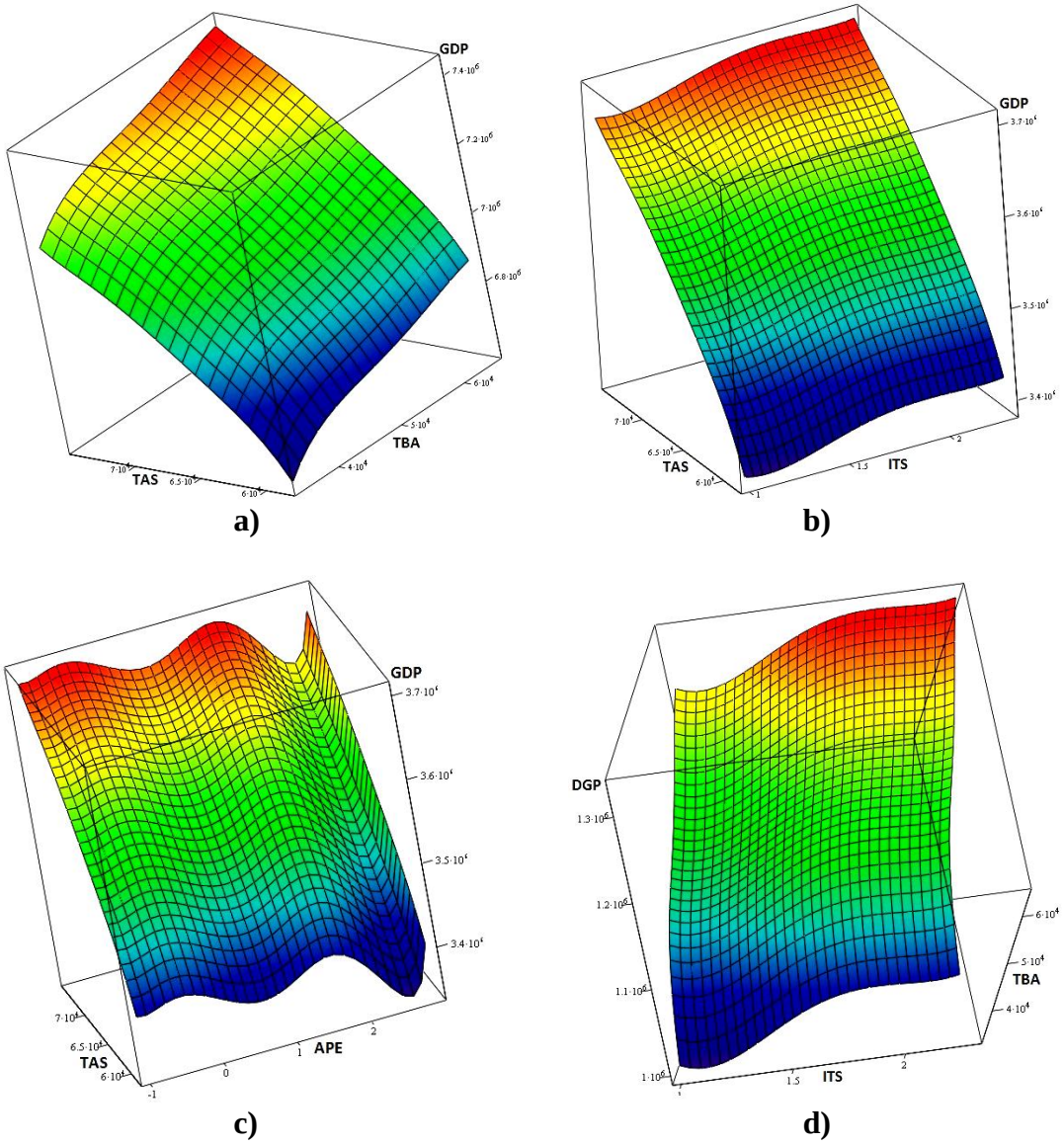
Source: Our own simulation with Mathcad 14.



a) **b)**

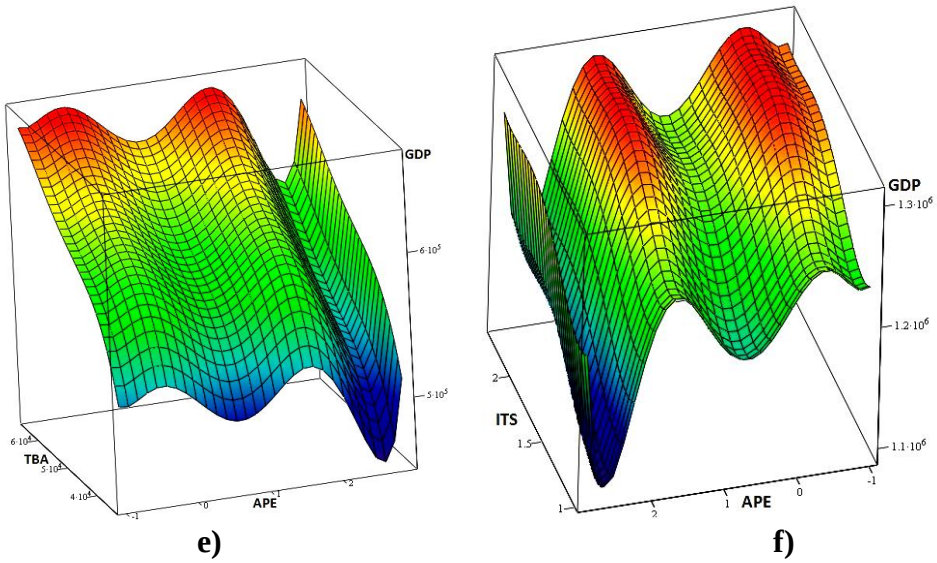
Figure 6. APE evolution: a) real data; b) trend representation.
Source: Our own simulation with Mathcad 14.

After the functions and graphs trends were obtained they were used to determine response surfaces which provides images on the values of influence on GDP data. The response surfaces are presented in figure 7, from a to f.



a) **b)**

c) **d)**



e) **f)**

Figure 7. GDP Surface evolution under the influence of: a) TAS and TBA; b) TAS and ITS; c) TAS and APE; d) TBA and ITS; e) TBA and APE; f) ITS and APE.
Source: Our own simulation with Mathcad 14.

Response surface analysis results can be seen in Table 3.

Table 3. The most influential data over GDP from each pair of data.

		Data			
		TAS	**TBA**	**ITS**	**APE**
Data	TAS		TAS	TAS	TAS
	TBA	TAS		TBA	TBA
	ITS	TAS	TBA		APE
	APE	TAS	TBA	APE	

4. CONCLUSIONS

Considering the response surface analysis can draw the following conclusions:

- The most influential data is TAS with almost 50%;
- Next influence has it the TBA data with 33.33% and APE with 16.67%;
- The weakest influence belongs to ITS.

Considering the influence of values determined by simulation results with ANN and the ones determined by plotting can be observed a total reverse of the situation. While in the ANN's simulation the most influential is ITS and the least influential was TAS, in the graphical representation the most influential is TAS and the least influential was ITS.

The result can be explained by two factors.

First the ANN those not consider a mathematical function that is used to reveal the relations between the data and the GDP, while the graphical representation cannot be done without it.

The second explanation consist in the type of function that is needed to represent that relations. Considering the paper results in graphic representations, it is obvious that the mathematical function form was not powerful enough to reveal a more accurate trend line.

ACKNOWLEDGMENT

More research is needed to study the comparison of the two methods above, especially regarding the form of the mathematical function is used in plotting trends.

Regarding the results of the comparison is clear superiority of ANN on graphical method due to easier and clearer way to evaluate model and simulate relationships between data with nonlinear developments.

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