ANALYSIS OF THE NONLINEAR STATISTICAL ANALYSIS METHODOLOGY APPLICABILITY ON MODELING THE CORRELATION AMONG GLOBAL MACROECONOMIC PARAMETERS

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Abstract

This paper presents the preliminary results of analyzing the possibility of modeling the interdependence between macroeconomic parameters: Dow Jones index – USA, Europe and Asia; prices of copper, oil and natural gas; and the EUR/USD, EUR/JPY ratios. Listed parameters were continually recorded for the longer period of time. Obtained results were subsequently statistically processed to determine the parameter with the initial effect. This was followed by attempt to further develop the model of their interdependence. The analysis was bases on the so called: “buoy effect”, as a now modeling approach under the conditions of uncertainty.

Key words: macroeconomic effects, modeling, nonlinear statistics

JEL Code: E17, C15

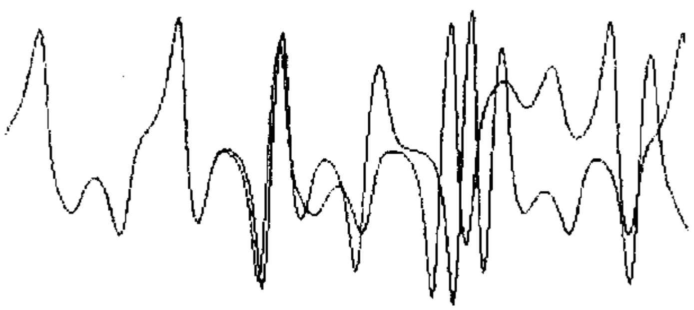
Introduction

This paper is about nonlinearity and the chaos in economic models. Trying to develop the model of interdependency of number of macroeconomic parameters is the issue of this investigation. This idea is not completely new. There are attempts to do such modeling in modern scientific literature, coming from different fields of sciences. Even Stephen Hawking gave his contribution to this scientific field in some of his statements. For example, one of his approaches was: "The stock markets are said to be nonlinear, dynamic systems. Chaos theory is the mathematics of studying such nonlinear, dynamic systems."

However, he realizes that ordinary people has opinion on the chaos theory as an complicated item which should be considered only by scientist and scholars. He disapproved this opinion in this next sentence:” If we do discover a complete theory, it should in time be understandable in broad principle by everyone, not just a few scientists. Then we shall all, philosophers, scientists, and just ordinary people, be able to take part in the discussion of the question of why it is that we and the universe exist."

Not only Hawking realized that the stock markets should be modeled by available mathematical tools. For example, there is an example which displays Dow Jones Industrial stock prices, Divisor, and average at month's close from December 31, 1990, to October 31, 1998, then extrapolates prices and divisor to 2001 and displays prices, divisor, and average to 2001. This example was integrated as a tool in a MLAB Mathematical Modeling System, Civilized Software, Inc, as a demonstration file. This model predicted the global DJI to the value of 2580. If it is further extrapolated to the year 2012, it will result with the value of global DJI of near 3000. We should have in mind that the base of this model was created from the data obtained in the period 1990 to 1998, so it is not realistic to expect higher accuracy, because of the phenomena which Edward Lorentz firstly realized in the early 1960's (Lorenz, 1963; Lorenz, 1966; C.A.Danforth, 2001). The findings of professor Lorenz relied on the theory of large number rows. Meaning, that in the case of large row of number modeling, the accuracu will increase if the extrapolation is not too far for the borders of investigated data set. This is because of the fact that in the dynamic systems, equilibrium states are changing their position in the time. Mowing far in extrapolation, will probably neglect the formation of some new equilibrium state in the future, as indicated in Fig.1.

Fig. 1: Inrease of discrapancies between measured and predicted values as the result of dinamichal change of the system



Off course, after those first results, there was further development of mathematical modeling of this kind (Bullard and Batler, 1993; Takala and Viren, 1996; Murphy, 1996; Guegan, 2009). Some of the interesting approaches are given in the manuscript recently published by Juarez (Juarez 2010). In this manuscript the author is dealing with defining the relations among the aggregate financial indicators based on the Lorenz equation.

1. Experimental methodology

Experimental approach behind the results presented in this paper is relying on one completely new approach. We defined it as a "buoy-effect". In this paper we tried to develop the model which will describe the intercorrelation among 13 starting input parameters, which all are representative macro economical indexes. These macroeconomic indexes which were taken in consideration are: WTI oil price (X1); Brent oil price (X2); the price of natural gas (X3); price of silver (X4); gold (X5); copper (X6); Dow Jones Index USA (X7); Dow Jones Index Europe (X8); Dow Jones Index Asia (X9); Dow Jones Index Global (X10); the EUR/USD ratio (X11); EUR/JPY ratio (X12) and the EUR/RSD ratio (X13) , just to test the influence of global macro economical indicators on local currency.

The most important parameter, which was the subject of intent, for our final model was the global DJI (X10).

The values of above parameters were selected on a daily base, at 20 O'clock each day, during 45 days. Thus, starting data base with 45 vectors of 13 dimensions was formed this way. Obtained results were than standardized in comparison to starting value (obtained on the first day of measurement), to obtain the buoy effect of each of 13 measured factors.

2. Results and discussions

After standardization of the 13 factors investigated, descriptive statistics was calculated for all the data. The results are presented in Table 1.

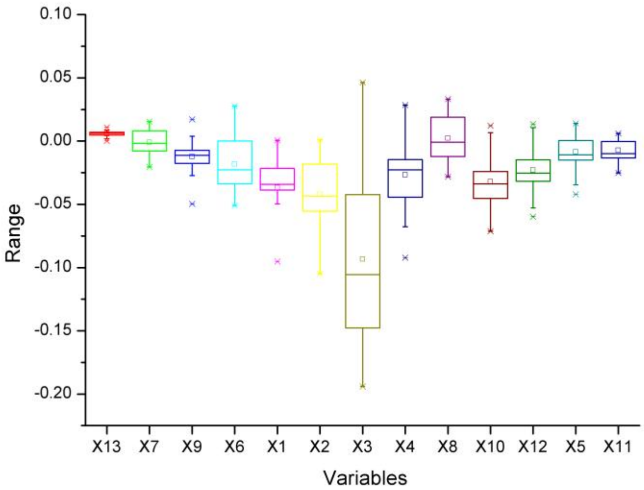
According to the value of the Range (Tab.1), the central "buoy" was chosen. The variable with largest range is the variable X3 (the price of natural gas). Remaining variables were that lined in the order of ranges, on the left and the right of the central buoy (X3), as presented in Fig. 2.

According to results presented at Fig.2 and the analysis of Pearson Coefficients of correlation, there is significant interdependence between the trends of variation of investigated variables. This can also be concluded according to the results presented in Fig. 3.

Tab. 1: Descriptive statistics of starting data set

	X1 pct	X2 pct	X3 pct	X4 pct	X5 pct	X6 pct	X7 pct	X8 pct	X9 pct	X10 pct	X11 pct	X12 pct	X13 pct
N Valid	46	46	46	46	46	46	46	46	46	46	46	46	46
Std. Dev	.0235	.0297	.0614	.0282	.0121	.0219	,0106	.0212	.0137	.0201	.0079	.0180	.0022
Variance	.001	.001	.004	.001	.000	.000	.000	,000	.000	.000	.000	.000	.000
Range	.0959	.1057	.2405	.1208	.0562	.0787	.0419	,1004	.0668	.0833	.0312	.0733	.0108
Min.	-.0952	-.1047	-.1940	-.0922	-.0421	-.0509	-.0265	-,0672	-.0495	-.0712	-.0250	-.0598	.000
Max.	.00065	.00103	.0464	.0285	.01409	.02782	.01548	,0332	.0173	.01215	.0061	.01351	.0108

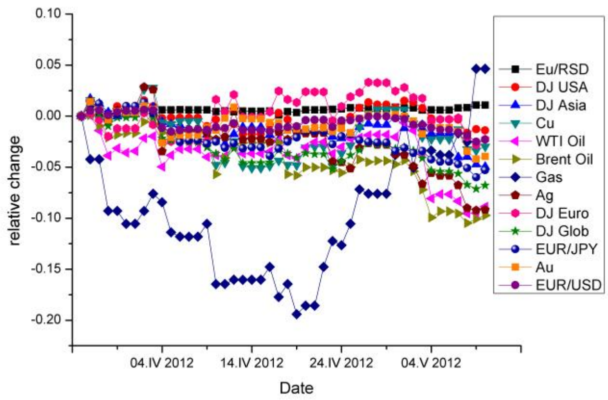
Fig. 2: Lining of the investigated macroeconomic factors in line according to their ranges



According to the results presented in Fig. 3. It can be concluded that most of the variables follow the similar trend of relative change, except variable X13 (EUR/RSD). This was also expected, considering that RSD value is kept almost constant based on interventions of National bank of Serbia. This way it is not following the natural trend of world's economy, like other currencies. From this reason, variable X13 was not included in following investigations.

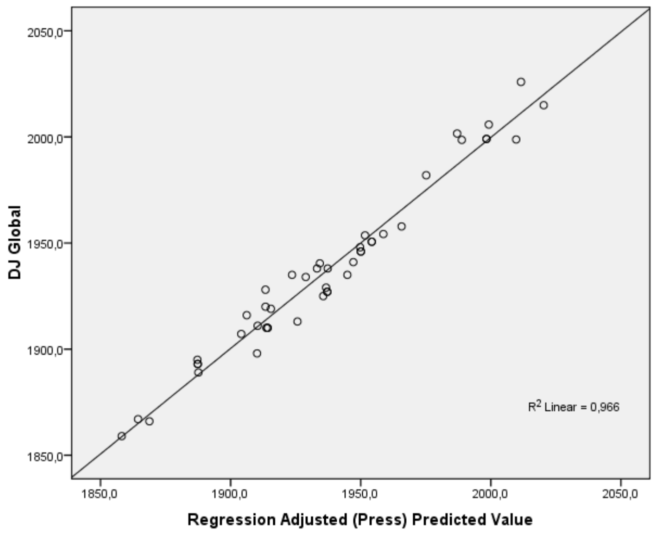
Further research was based on the attempt to develop the model which will present the dependence of Dow Jones (DJ) global index (X10) on remaining input variables. The modeling was firstly performed based on Multiple Linear Regression Analysis (MLRA), because of high correlation among the investigated variables (Đorđević, et al., 2010). The appropriate model was developed using the stepwise MLRA methodology. The results are presented in Table 2. According to the results presented in Table 2, it can be concluded that the DJ global can be presented as the dependence of EUR/JPY (X12), copper price (X6), Brent oil price (X2) and the DJ USA (X7). Remaining factors didn't remain in the final model, because they didn't have required statistical significance ($p<0.05$). Final model had large coefficient of determination ($R^2 = 0.966$) as presented in Fig. 4.

Fig. 3: Trends of relative change of the investigated macroeconomic factors in time



The coefficient of predictivity of developed MLRA model is presented in Fig. 4. Considering that MLRA could not product the model which will include all targeted macro economic factors, further modeling was performed using nonlinear statistic approach. As the modeling tool artificial neural networks (ANNs) was chosen. The ANN architecture which resulted with high accuracy of prediction is presented in Fig. 5.

Fig. 4: Dependence between measured and MLRA model predicted value of DJ Global

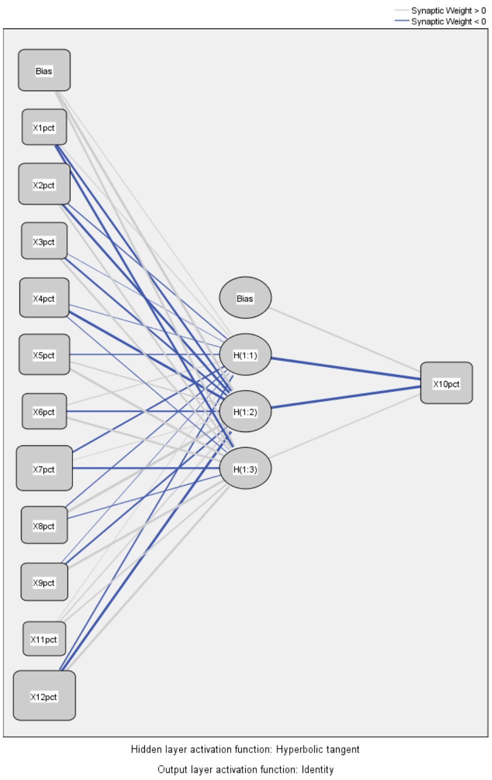


Tab. 2: Stepwise MLRA model of investigated variables

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	-,008	,002		-4,631	,000		
	X12 pct	1,035	,063	,927	16,402	,000	1,000	1,000
2	(Constant)	-,008	,001		-5,857	,000		
	X12 pct	,843	,053	,755	15,768	,000	,705	1,418
	X6 pct	,292	,044	,317	6,633	,000	,705	1,418
3	(Constant)	-,005	,001		-5,110	,000		
	X12 pct	,581	,054	,521	10,668	,000	,338	2,956
	X6 pct	,302	,031	,328	9,682	,000	,704	1,421
	X2 pct	,201	,030	,297	6,651	,000	,405	2,469
4	(Constant)	-,007	,001		-6,393	,000		
	X12 pct	,548	,051	,491	10,781	,000	,323	3,094
	X6 pct	,195	,045	,212	4,366	,000	,284	3,520
	X2 pct	,219	,028	,323	7,765	,000	,388	2,574
	X7 pct	,277	,090	,146	3,080	,004	,297	3,370

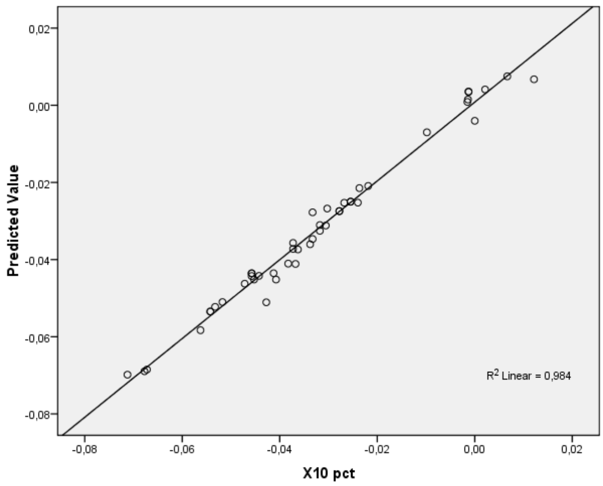
a. Dependent Variable: X10 pct

Fig. 5: Architecture of optimal ANN for macroeconomic factors modeling



ANN architecture which presented highest accuracy of prediction of the DJ Global, based on the values of all remaining input variables, consisted of one input, one hidden and one output layer. Hidden layer was consisted of 3 nodes and one bias . Training phase was conducted on 78 pct of randomly selected vectors of starting data set, while the testing of the model was completed on remaining 22 pct. Obtained coefficient of determination of obtained ANN model was $R^2 = 0.984$, as indicated in Figure 6.

Fig.6: Dependence between measured and ANNs model predicted value of DJ Global



Conclusion

According to the results presented in this paper it can be concluded that there is correlation between investigated macroeconomic factors. Also, this interdependence could be presented as influence of dynamical change of values of the factors, which was denominated as the “buoy-effect”. This phenomena will be the subject of our further investigation.

As the factor with higher range of relative change, in investigated period, the price of natural gas was abstracted. The influence of the natural gas price on remaining macroeconomic factors, important for worlds market, was predicted by Hartley and Medlock in the frame of their research prepared for the Geopolitics of the Natural Gas Study (Hartley and Medlock, 2005). Also, the possibility of modeling the dependence of global DJ index of important macroeconomic factors was proven.

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