AN EVOLUTIONARY ADAPTATIVE METHOD FOR SHORT TERM FORECASTING OF THE EXCHANGES RATE

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Abstract: *The paper presents a new method to forecast the variation of the exchange rate Euro-RON on a short period of time, using an evolutionary adaptative model of the behavior of the market and a genetic algorithm to forecast the variation of the exchange rate.*

Key words: *Genetic algorithms, Financial market forecasting, J.E.L. classification: G 17, C 63*

INTRODUCTION

Among economic systems which have aroused a keen interest in the field of Complexity Science specialists, financial market occupies a privileged place.

The classical financial market theory, developed on the basis of conceptions take on market equilibrium formation of Alfred Marshall, starts from the idea that one can establish a deterministic or probabilistic connection between cause and effect and that this connection may be predictable.

From this point of view, the classical theory on determining the exchange rate, which is subordinated to financial market efficiency hypothesis, is built on the assumption that the prices of the financial asset would be perfectly independent one of each other. Consequently, changes in prices are determined only by the emergence of new information, unexpected on the market, which is also random and unpredictible.

An alternative to this theory would consider the financial market as a complex adaptive system being composed of lots of independent agents, and that presents emerging group behaviors. Agents from a complex adaptive system collect the informations in their environment, then combine them with their own interactions with the environment and, hence, produce their own decisions and decision-making procedures. Of course these decisions and procedures will be competing with each other, being compared against a „fitness" and only the most effective strategies makers will survive [1]. This behavior posses some similarities with the non-Darwinian biological evolution, and justify our aproch.

The most common technique to obtain an applied evolutionary adaptative model (EAM) is the use of genetic algorithms, which allows the searching for solutions to a specific problem, represented as vector of numbers, using procedures inspired by biology, such as recombination and mutation.

In this paper we present an application of this technique to the problem of the forecasting the variations of the excenge rate Euro-RON (Romanian leu)on a short period of time.

MATERIALS AND METHODS

An evolutionary algorithm is a search method by analogy with biological evolution (non-Darwinian) [2]. To find the solution we use a "population" of potential solutions that evolves by applying iterative stochastic operators. Items of the population, called "chromosomes", are potential solutions to the problem.

In the particular case of the modeling of exchange rate variation, a particular chromosome will be formed by a vector of real numbers $(x_i)_{i=1,q}$ of predicted daily absolute variation of the exchange rate, on a period of *q* consecutive days (in the particular case of the impelented algorithm we choused *q*=7). The "population" will be constituted by a *nrCrom=100* chromosomes, modeling the prediction of a correspondent numbers of foreign currency agents.

To guide the search for a best solution of the forecasting problem, we will apply some specific transformations on the chromosome population suggested by the natural evolution, like the cross-over transform, the mutation and the selection of the chromosomes. The selection depends on the "fitness" value associated to each individual of the population, a function that measures the a degree of the adequacy of the correspondent partial solution of the problem [3].

In order to define a fitness value associated with each prediction vector, the model select, in the last year, four periods W_1-W_4 of 14 days when the variation of the exchange rate is similar to the variation in the last two weeks before the starting day of the prediction. The measure of the similarity is the standard deviation values, and this method needs the knowledge of the variation of the exchange rate on the last year.

For each W_j of the chosen four periods, the chromosome of predictions $(x_i)_{i=1,q}$ is compared to real exchange rate variation $\mathbf{\Delta r}_{i,W_j}$, and the standard deviation is considered as a measure of adequancy:

$$Ad((x_i)_{i=1,q}) = 100 \sum_{j=1,4} \frac{\sqrt{\frac{1}{7}\sum_{i=1,7}(x_i - \Delta r_{i,W_j})^2}}{4} \quad (1)$$

where the multiplicator *100* was introduced to express the value of the deviation in *bani* (100 bani=1RON).

The inverse of this value

$$Fit((x_i)_{i=1,7}) = \frac{1}{Ad((x_i)_{i=1,7})} \cdot 100(\%) \quad (2)$$

will be the *fitness* function.

Next, the model will evolve the population of chromosomes in order to obtain best prediction vector, according to the classical method described in [4].

This model implements the supposition that the real agents develops in time *particular* reaction to the behavior of the market, and statistically have similar approaches on similar variation of the exchange rate. The variation of the rate does to strong economic shocks or political reasons are not tacked into consideration

RESEARCH RESULTS

In the initial stage, the algorithm generates the chromosomes at random using a maximum permissible value of the daily variation.

After that, the population is partitioned into pairs of chromosomes to witch we apply the crossover operator to produce two new (child) chromosomes. Subsequently, we apply the mutation operator to the genotypes of the newly produced children.

The cross-over operator between two chromosomes exchanges a random length suffix between the two prediction vectors. The mutation is probabilistic and random modify one of the predicted value for one of the day with a small value.

After computing the fitness of each child individual, we add the children to the current population, leading to a population size of 2 *nrCrom*. Then we apply the selection operator to reduce the population to its former size, using the best *fitness* value. Doing so, we obtain a nest generation to which we again apply the same procedure and so on. This process is repeated for a specified number of generations (in our case *G*=800. See also [5] for more examples of this algorithmic technique).

We give below the schematic description of the algorithm

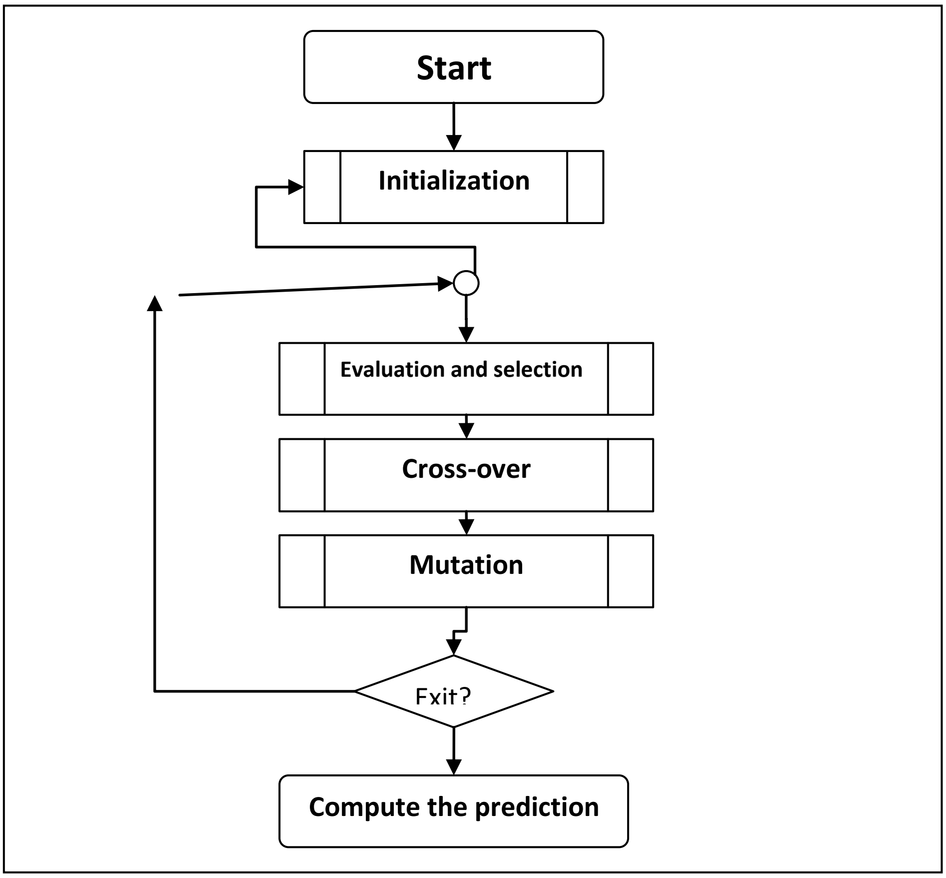

Figure 1 The Evolutionary algorithm schema

or in Pseudocode:

Initialize(Popupalion[])

For n=1 **to** G, **step** 1, **do**

Begin (__GENERATION n __)

//*compute NEwPopulation*

For i=2 to nrCrom/2, **step** 1, do

Crossover(2*i-1,2*i,2*i-1,2*i);

For i=3 **to** nrCrom, **step** 1, **do**

mutation(i)

For i=3 **to** nrCrom, **step** 1, **do**

ComputeFitness(i)

sort(Population, NewPopulation);

select(nrCrom);

End (for)

At the end, the best 4 prediction is used to produce an average prediction vector for the variation of the exchange rate in the nest seven days, and the values of the prediction were computed starting with the current rate.

The model implemented have use the European currency market study, focused primarily on the study of change of a rate euro-leu on the last year, obtained from http://curs-valutar.efin.ro/arhiva-curs-valutar-euro-2015.

We give the result of the simulation of the algorithm for the third week of the November 2015 (the real exchange rate is in blue)

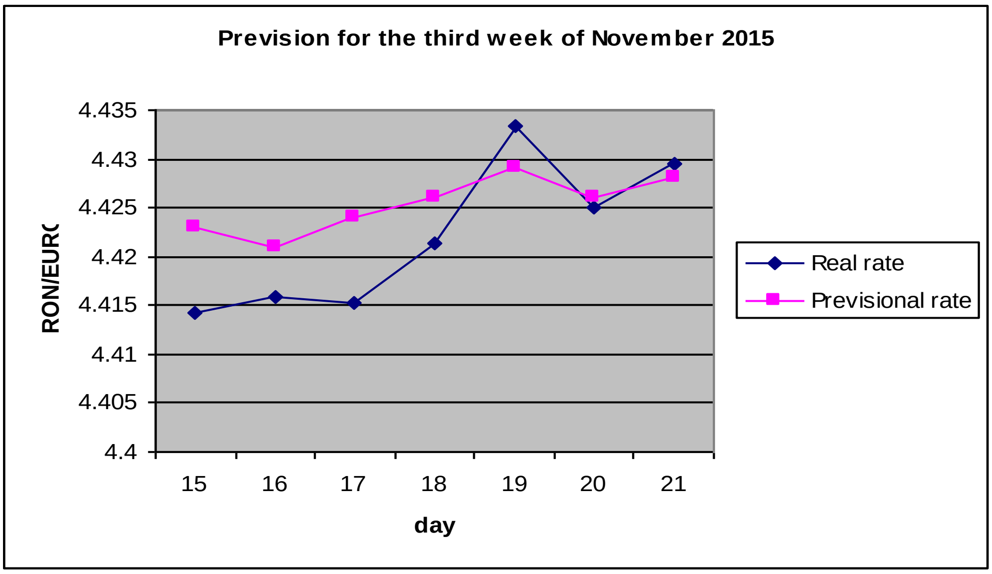

Figure 2 The prediction values of the exchange rate versus the real one for the third week of November 2015

The values are tabled below

Table 1

The predicted values of the exchange rate for the 3th week of November 2015

NovDay	Real rate	Predicted rate
15	4.4142	4.423
16	4.4158	4.421
17	4.4152	4.424
18	4.4213	4.426
19	4.4334	4.429
20	4.425	4.426
21	4.4295	4.428
22	4.4291	4.4291

The correlation analysis of the result gives a correlation coefficient between the real rate and the predicted one: *Cor= 0.923*, and the value of the F-test for variance with the confidece level 95% is F=7.1939, when the critical values is F_{crit}=4.2838, that indicate a strong correlation between the predicted values and the real ones.

The same algorithm give for the 3th week of September 2015 the results from the Table 2

In this case the correlation coefficient between the real rate and the predicted one is

Cor= 0.572, and the value of the F-test for variance with the confidece level 95% is F=1.1277. The prediction in this case is less acurate that in the precedent one.

Table 2

The predicted values of the exchange rate for the 3th week of September 2015

Sept. Day	Real rate	Predicted rate
15	4.4195	4.4210
16	4.4239	4.4250
17	4.4267	4.4240
18	4.4211	4.4190
19	4.4211	4.4200
20	4.4211	4.4180
21	4.4229	4.4320

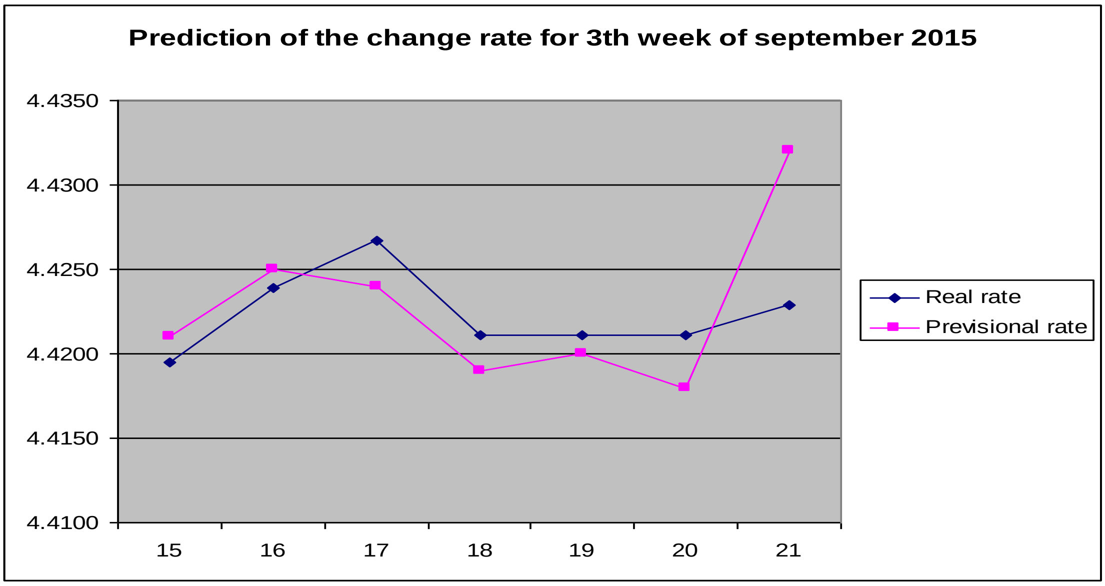

Figure 3 The prediction values of the exchange rate versus the real one for the third week of November 2015

Using the algorithm for another 8 weeks of the 2015, one obtained an average correlation coefficient *Corr*=0.72, and the confidence level should be decreased to 85 % in order that all the 10 prediction pass the F-test.

CONCLUSIONS

First observation is that the computational results validate the proposed algorithm as a method of short term prediction for the variation of the exchange rate between Euro and RON.

Concerning the efficacity of this method, Nelson şi Winter ([1]) argumented in their book that in the case of standard Genetic Algoritm, both cross-over and mutation leads to changes in chromosomes that are highly random, even showing divided distributions. In the case of an evolutionary algorithm (EA), those changes which do not attain the right accuracy are removed. But the random character of this kind of market limits even the benefit of the EA use.

The applicability of the EA presented in this paper is strongly limited by external factors as the possible interbention of the Cental Bank on the valutary market, the seasonal phenomena as the period of holiday for the Diasporas and crisis shocks.

In the future, it could be an interesting alternative to replace the crossover operator and the selection one with an operator that involve selective transfer of information between chromosomes. In essence, this operator would be based on a filtered form of duplication subsequences of a sequence to another; without excluding the possibility that the entire sequence to be copied. The mutation would remain the generator of pure random variations.

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